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JANUARY—JUNE, 1914

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

POWER DEVELOPMENT AT CEDARS RAPIDS, QUEBEC

THE PROGRESS THAT HAS BEEN MADE ON THE CONSTRUCTION OF CANADA'S SECOND LARGEST HYDRO-ELECTRIC DEVELOPMENT—DESCRIPTION OF THE PLANT

HYDRO-ELECTRIC development in the Montreal district has made rapid strides of late, and is on a scale that anticipates a great demand for power in the near future. Among the various activities, construction work has been progressing favorably since spring upon the hydro-electric power station of the Cedars Rapids Manufacturing and Power Co., near Montreal, Que. It is stated that when completed it will be the largest in Canada, with the exception of the Ontario Power Company's development at Niagara Falls.

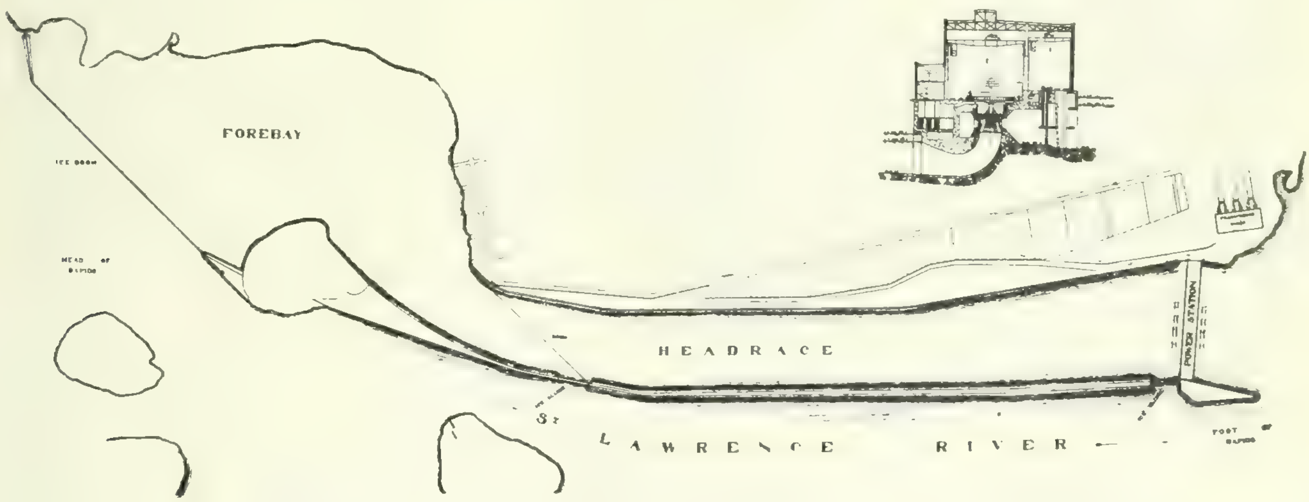

Fig. 1.—General Arrangement of Plant, and Cross Section of Power House.

About fifty miles above Montreal the St. Lawrence River widens out into Lake St. Francis. Above this lake there is a long series of rapids, known principally by the name of the longest one, the Long Sault. Lake St. Louis lies below Lake St. Francis, nearer Montreal, and between these two lakes the river falls through a distance of about eighty feet, made up chiefly of three rapids, namely, Coteau, The Cedars and the Cascade. The Cedars Rapids have a fall of 32 feet, and are located about 30 miles west of Montreal. At this point, the above company is constructing its power station to have an initial rating of about 100,000 h.p., and later to be increased to 160,000 h.p. The general arrangement of the development, showing forebay, headrace and power site, is illustrated in Fig. 1.

A brief summary of surrounding conditions on the St. Lawrence may be of interest. The Department of Railways and Canals, of the Dominion Government, maintains canals on both sides of the river for navigation past these three rapids. That on the south is the Beauharnois Canal, and that on the north, the Soulanges Canal. The former has been practically abandoned for navigation purposes, all traffic from the the Great Lakes to the Atlantic passing through the Soulanges.

The standing of the St. Lawrence River among the other great rivers of the world is well known. It drains a territory of over 300,000 square miles, a large percentage of which is lake area. Its steadiness of flow renders it distinctive among the largest rivers, the ratio of the maximum and minimum over a yearly period of time has not been known to exceed 3 to 1. Comparing this with the flow, for instance, of the Mississippi, which has a range of 25 to 1, or with the Susquehanna, which has a range of 75 to 1, the remarkable uniformity of the St. Lawrence River flow becomes a factor of inestimable value to any water power development.

For many years the development of the rapids in the St. Lawrence has been discussed, and numerous plans have been made, based upon different types of installation. According to the waterways treaty existing between Great Britain and the United States, which established the International Waterways Commission, any water power developments made on the St. Lawrence are subject to the approval of that commission. No diversions of the water from the river are permitted without careful investigation by that body, so as to insure that the levels for navigation purposes are not affected. In this connection it is to be stated that the commission, and the Dominion Govern-

ment as well, placed their marks of approval upon the proposed plan of works. The company may use 56,000 feet per second, sufficient to develop 160,000 electrical horse-power.

Headrace Construction.—The rapids at Cedars extend over a distance of about two miles. To concentrate this fall, a canal is being constructed along the north bank of the river, as shown in Fig. 1. The southern wall of the canal is built up from the rock excavated from the canal section, and is made watertight on the canal face by clay filling. This combination rock-fill earth bank requires special precautions against leakage or possible damage, the factors of safety being necessarily large. The type of construction, which is quite common in the case of large water reservoirs was considered to be the most economical, as all the materials were available at the site, and as the maximum head against the bank would never exceed 32 feet.

The water will be taken in above the Cedars Rapids between the Isle-aux-Vaches, forming the upper end of the dam, and the main shore. From this island to the power house there will be a length of canal of about 12,000 feet, forming a dam which concentrates about 32 feet of the fall. Fig. 2 is a view taken from Isle-aux-Vaches looking toward what will ultimately be the mouth of the canal. It shows the cableway used for the construction of the dyke extending the full length to the power house. The upper end of this earth bank, about 2,000 feet in length, is being constructed across a bay of the river and the material is being dumped from the cableway. The thin earth bank shown on the left is being retained at the present time to act as a cofferdam so that the main canal excavation may be carried on with steam shovels in dry ground.

The width of the canal on the water line will be about 1,000 feet. When finished its outer or south bank will be practically a straight earth wall two miles long and parallel thereto the shore forms a similar bank located on the natural flow of the river.

Ice Fenders.—The type of ice fender to be constructed at the upper end of the canal to divert floating ice from Lake St. Francis will consist of a number of submerged openings permitting the entrance of water into the canal at five or six feet below the surface. As this ice fender has the same general direction as the main current of the river, the ice which strikes the fender will be carried along by the heavy current and its own momentum, without entering the canal or impeding the entering flow. The usual precautions will be taken with respect to frazil ice, although in plants with these larger units a considerable amount may pass through the wheels without fear of causing interruption.

Power House Construction.—The power house will extend across the lower end of the canal forming a portion of the dam, giving, as stated, a fall of 32 feet. The building is 663 feet long, 140 feet in width, and from the rock to the top of the foundations is about 50 feet. The power house itself is being built of concrete, both foundation work and superstructure. The concrete work, at the present time, is finished to proper grade and the erection of the steel framework and superstructure is now being proceeded with. Fig. 3 illustrates the progress that has been made, three of the ten main units being completed and the others in a partial state. The method of construction of the draft tube for one of the main units is shown in the foreground. The illustration also shows to advantage the movable cantilever frame for the distribution of concrete. At this date work is in progress on the erection of the reinforced concrete units which are to form the power house superstructure. During the winter, and as rapidly as the foundation work will permit, steel will be assembled and these slabs put into place, so that waterwheel installation can go forward without delay.

Fig. 2.—South Bank of Canal Under Construction, View from Isle-aux-Vaches.

Power Plant.—The great improvements that have taken place during the past few years in the design of low head water turbines and single-runner wheels at reasonable speeds to develop large amounts of power is being taken advantage of to a marked degree, although the policy has not been to endeavor to obtain the largest available units. The generating equipment includes twelve 10,800-h.p. waterwheels of the single-runner vertical-shaft type, which are to operate at 56 r.p.m. under a head of 30 feet. There will also be three 1,500-h.p. exciter units which will operate under the same head at 150 r.p.m. The plans for the final development call for eighteen 10,000-h.p. units. The size of each unit is stated to have been chosen more with a view to economic operation and confidence in its reliability than with the endeavor to save a small amount by greatly increasing the size.

The intakes are of the scroll or involute type. The water passes through the racks at the up-stream face of the power house into the reinforced concrete flume, thus entering the wheel, and discharging through a centre draft-tube into the tailrace and the river. The wheel chambers are of spiral shape, formed in the concrete foundations of the building. The generator for each wheel is to be located immediately above. The weight of the moving parts will be carried on a thrust-bearing located above the generator, readily accessible for inspection and maintenance, and easily reached with a crane

Another feature is that the overall length of the generator and wheel is thus reduced to a minimum, and necessitates only two guide-bearings for the vertical shaft.

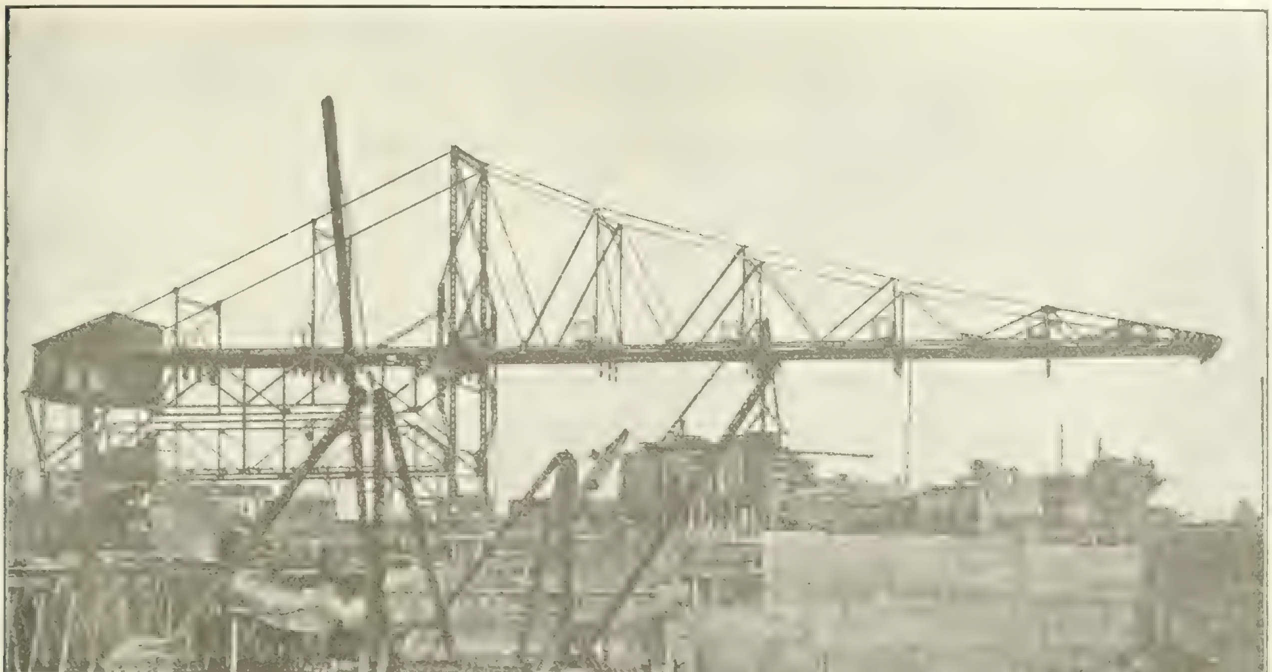
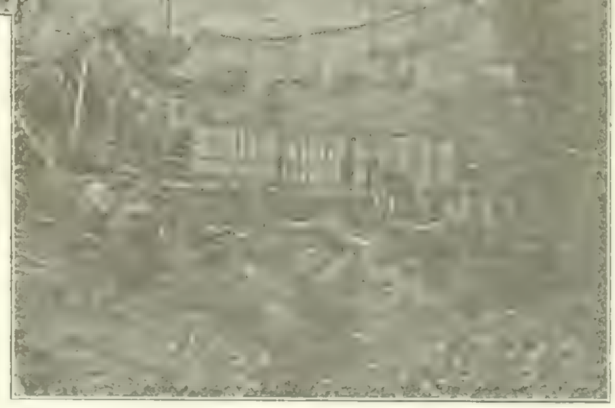

Fig. 3.—Power House Substructure, Showing One Draft Tube Under Construction.

In the design of the plant, an effort has been made to place on the main floor all the equipment that is vital to the continuity of its operation. This dispenses with an unfavorable feature of many vertical water power developments, in which the governor and thrust-bearing pumps and other auxiliary machinery are located below the generator floor, where they are not readily accessible for repair or close supervision, although ample floor space above is thus obtained.

Fig. 4.—Placing of Column Footings, Transformer Station.

The transformer house is to be constructed to take care of 100,000 h.p. initially. The building is quite separate from the power house, and is located on a higher elevation about 300 feet distant. Fig. 4 shows the commencement of work on the transformer house, and illustrates the excavation and placing of the footings for the columns and walls of the building.

Progress.—It is anticipated that the plant will be ready for the deliverence of 100,000 h.p. in October, 1914. The progress that has been made up to date is as follows:—

	Per cent. completed.
Rock excavation	23.2
Earth excavation, other than stripping and trench work	60.0
Earth excavation, in trenches and ditches, and stripping seats of banks	84.0
Transporting and placing of excavated rock	27.7
Stone protection	2.7
Transporting and placing of excavated earth	62.5
Concreting of power house substructure	25.5

The work constitutes the removal of about 700,000 cu. yds. of rock, and 1,600,000 cu. yds. of earth excavation. There will be a total of 80,000 cu. yds. of concreting.

Personnel.—The Cedars Rapids Manufacturing and Power Company was organized with ample powers for the development of water power at Cedars Rapids, and for the construction of transmission lines. The lands

were acquired, and, as stated, the approval was obtained of the International Waterways Commission and of the Dominion Government. As a result of its magnitude, however, and of the fact that the greater portion of the development would necessarily have to be made before any power could be obtained, this power stood idle until the control became vested in the joint interests of the Shawinigan Water and Power Co., and the Montreal Light, Heat and Power Company. Soon after this transfer of control contracts were made with the Aluminium Company of America to take 60,000 h.p. and with the Montreal Light, Heat and Power Company to take 20,000 h.p. These contracts practically insured the success of the venture from a financial standpoint, and work was immediately commenced. The president of the company is Mr. J. E. Aldred; its hydraulic engineer is Mr. J. C. Smith, and its electrical engineer, Mr. R. M. Wilson.

The turbine units are being constructed by the I. P. Morris Company, of Philadelphia, and the Wellman-Seaver-Morgan Company, of Cleveland. The first three turbine units have already been delivered. Three electrical generators are also on the ground, being supplied by the General Electric Company of Connecticut. The work of installation will be commenced about January 1st, 1914.

THE POWER PROBLEM IN THE ELECTROLYTIC DISPOSITION OF METALS.

A joint meeting will be held on January 9th, 1914, in the Engineering Societies Building, 29 West 39th Street, New York, by the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the American Electrochemical Society, to discuss the above problem. The following illustrated papers will be presented:—

The Limitations of the Problem, Lawrence Addicks, A.E.S. A brief statement of the conditions imposed by practice in the electrolytic refining of copper as a typical process.

The Mechanical Side of the Problem, H. E. Longwell, A.S.M.E. Application of gas and steam for driving generators of the type required.

The Electrical Side of the Problem, F. D. Newbury, A.I.E.E. Application of various D.C. and A.C.-D.C. apparatus to furnish current of the required dimensions.

As the subject is a much broader one than the typical case chosen for the formal papers, an interesting discussion is expected.

A report of the United States Bureau of Mines, which deals with fatalities in the metal mines of the country for 1912, shows that Michigan has reduced its total of deaths in the copper and iron mines from 134 in 1911 to 96 in 1912; and that Minnesota has reduced its total deaths in the iron mines from 76 to 50 in the same period. The death rate for every 1,000 men employed in Michigan was 4.24 in 1911 and 3.26 in 1912; and in Minnesota 4.59 in 1911 and 3.02 in 1912. The Bureau's report on metal-mine accidents in the United States in 1912, shows 661 men killed, 4,502 seriously injured and 26,232 men slightly injured, out of a total number of 169,199 men employed. The figures show a decrease of 34 deaths from 1911, despite the fact that Alaska, with 21 fatalities is included for the first time in the 1912 report. The death rate for 1912 was 3.91 for every 1,000 men employed as against 4.19 in the year 1911. The report completes the mortality statistics for the mining industry for the year 1912 and shows in coal mining, metal mining and quarrying, a total of 3,234 deaths for the year, with a death rate of 3.22 as against 3,602 deaths in 1911 and a rate of 3.58 in every 1,000 employed.

PRACTICABLE MEASURES FOR CIVIC BEAUTIFICATION.

An article by Fred L. Macpherson, municipal engineer, Burnaby, B.C., in December 18th issue of *The Canadian Engineer* outlined the place of tree-planting in civic beautification, and presented a weighty argument in favor of more trees and more boulevards in towns and cities, emphasizing the necessity of combining the efforts of the municipal engineer and the landscape architect for efficient results. The following information respecting the same subject, in conjunction with the article referred to, formed a paper presented to the Burnaby Board of Trade last month:

Boulevarding.—This feature of street beautifying does not require so much skill and experience as tree-planting, and if the boulevards are previously rough-graded and curb constructed by the corporation, it should be a simple and easy matter for the property owner to undertake the fine grading, supply any necessary top soil, and sow the seed. The chief essentials of a good boulevard are good top soil, efficient drainage, evenness, uniformity and spaciousness. After the boulevard has been rough-graded it is advisable to loosen the soil with a mattock to a depth of from 8 to 10 inches in order to get rid of the surplus stones and afford better drainage. In very wet places tile or stone drains should be put in. In unpaved streets or in the absence of stone curbs, wooden curbs should be constructed to define the limits of the travelled road-bed, to retain the earth in the boulevard and to prevent it from being damaged by vehicular traffic. Where a curbing system is not adopted the boulevard is likely to have a ragged and incomplete appearance, and to be injured by traffic. In cases where the boulevard is not intended to be regularly mown only white Dutch clover, at a rate of about 1 pound for every 300 square feet should be sown, but where permanent boulevards are desired the use of lawn seed with a small percentage of white clover will produce a fine, velvety turf.

Where the property is a few feet above the level of the roadway very pretty effects can be obtained by planting broadleaf ivy on the slopes down to the sidewalk. On very broad boulevards two rows of trees are often planted, and sometimes evergreen shrubs are planted alternately with the trees either on the parking strip between the sidewalk and the curb or next the property line.

As regards fences and hedges, this is a matter for individual taste. Hedges, particularly evergreens, play an important part in a boulevarding scheme, but ordinary fences, particularly high fences, usually tend to mar the finished appearance of the boulevard. While fences are permissible for proper protection from the ravages of dogs, the prettiest and fullest effects are produced when the lawns fronting residences are an integral portion of the street boulevard. For the purpose of defining the property line a low concrete wall or curb about 9 inches high might be used without taking away from the spacious appearance of the boulevard. On our rural highway hedges of beech, hawthorn and privet such as are in adoption in the homeland could be introduced with advantage to the beauty of the rural landscape.

The use of rose bushes as a streetscape feature is worthy of commendable mention. Portland has earned world-wide name and fame as the "Rose City" and set a rosy example for other cities and districts to imitate if not to emulate. Here is a striking instance of what can

be done by public-spirited and civic-inspired citizens to give beauty and life and character to a city. While roses would not bloom so early in this district, the soil is suited for their culture and there is no reason why the rose boulevard system should not be introduced with happy effect in the more strictly residential districts hereabouts.

A highly important feature more or less directly associated with any boulevard beautifying scheme is the fixing of the building line. It is a matter for common regret and sometimes, civic reproach, that property owners are permitted to build as far away from or as close to the property line as their individual taste or desire elects. In few cities or districts there appears to be any restrictions as to the limit at which houses, particularly on residential streets, may be built, from the property line or the distance at which they may be built from adjacent houses. Apart from the sanitary drawbacks and the fire hazards resulting therefrom, the irregular and unsymmetrical effects produced are detrimental to the most happily conceived street beautifying scheme. Strict attention to or gross neglect of this vital matter will make or mar the realization of any boulevarding system. A building limit should be prescribed in any model building by-law, and rigidly enforced.

Cost.—As regards the cost of tree planting and boulevarding, conditions and circumstances vary so much as to render cost data unreliable. Trees cost from 50 cents to $1.50 each, depending on the age and species, and whether they are reared in private or corporation nurseries. The cost of tree-planting will range from 30 cents per tree to as much as $2 where hardpan has to be removed and prepared soil furnished. Providing protection guards would be additional to the above costs. The cost of preparing roughly graded boulevards, and soiling and sowing will average about 40 cents per square yard. As for the cost of maintaining boulevards, reliable records do not appear to be available, but 5 cents per foot front or about 6 cents per square yard is a customary allowance for yearly maintenance.

From the accompanying statement of comparative data procured from different places in Canada and the United States—and it is remarkable how very little reliable data is available—will be gleaned some interesting information regarding the question of boulevarding and tree-planting.

Public Squares and Play Grounds.—A passing reference to the part which public play grounds and squares play in any civic beautifying scheme may not be out of place. A glance at the map of Burnaby is sufficient to impress one with feelings of disappointment and resentment that little or no provision has been made for public squares and play grounds. This is only one of many regrettable instances in which the exploitation of real estate interests for pecuniary gain has predominated in the subdivision of property regardless of public interests and prospective civic requirements. In the sane and economic development of property sufficient space should be reserved by property owners in the central portion of almost every district lot, for public squares and play grounds. It is remarkable as it is regrettable that in this country there are comparatively few wealthy citizens—usually made wealthy through the sale of land—sufficiently magnaminous and public-spirited to bequeath such public benefactions as sites for public squares. Meantime, the provincial adoption of a Town-planning Act similar to that which has been in beneficial operation in Britain since 1909, would prevent, or at least restrict, the present merciless land exploitation and insure the planning and development of any city or district along sane, healthy and intelligent lines.

As regards the beautifying of school play-grounds, many authorities have given little or no consideration and care towards making them more adaptable and attractive for what they were primarily intended—namely, playing grounds. The seeding of the grounds and the judicious planting of ornamental trees and shrubs—which could be accomplished at comparatively small cost—would serve the edifying purpose of inspiring in children the love for and reverence towards Nature, besides providing for healthful recreation for the young. Now that our streets are rendered more dangerous through increasing automobile traffic suitable and easily accessible playing grounds are an imperative necessity for the free use of children.

Control of Shade Trees, Etc.—The all-important question of the control of and the regulation of the planting and preservation of shade trees and the maintenance of boulevards, is one which deserves the widest and maturest consideration, to the end that the best interests of public corporations as well as private citizens be duly respected and conserved. As things are at present in nearly all our cities and districts such matters are left almost wholly to the care and caprice of property owners with what incomplete and unsatisfactory results is all too apparent. Frequently on one street there are three or four kinds of trees, desirable mixed with undesirable, all sizes and shapes, and varieties, planted too close or too far apart, untended and untrimmed. The results are obvious. While the enterprising and well-meaning efforts and achievements of property owners should not be discouraged or discounted, the fact remains that it is only when the rights and privileges of undertaking such beautifying work are vested under one authority and under the proper supervision of an efficient department that entirely successful and satisfactory results can be ultimately produced. In most cities such matters are entrusted to the dual, care and control of both the engineering department and the park board, invariably with indefinite and imperfect results—a case of anybody's business being nobody's business. Being distinct from ordinary street work, such matters would be better left entirely in the hands of a capable park board, or in the absence of such, a properly constituted boulevard and shade tree commission. This also forcibly applies to maintenance, for when planted shade trees become a public asset and therefore should not be left to the care and custody of the average inexperienced and indifferent property owner. On the other hand, it might be justifiably argued that giving such boards or commissions absolute authority in such matters would be derogatory to private interests and rights and might even permit of vandalism. The ruthless mutilation of street trees to accommodate companies operating telephone or light and power systems with the property owners powerless to object or prevent might create an undesirable state of affairs. According to the Ontario Tree Planting Act, trees left or planted on public highways become the property of the adjacent property owners. Neither municipal authorities nor property owners can, in that province, legally remove or interfere with street trees without the will and consent of the other interested party. Such a regulation has much to commend it, for without such protection property owners would have no insentive to plant trees on their own initiative. Generally speaking, however, one properly organized and competent body should have the

power to direct and regulate the planting and preservation of street trees and the construction and maintenance of boulevards. With the growth of the boulevard movement it is being more and more generally recognized that such a system is more efficient and economical in the long run. Such work being particularly of a private nature, the cost should reasonably be assessed on the property owners directly benefited thereby, although in some instances the corporation might justifiably contribute a small proportion of the annual cost of maintenance. Most corporations pass by-laws to validate such beautifying schemes but it is one thing to enact and quite another to cause to act. The movement is deserving of more encouragement and greater support than it usually receives from municipal authorities, whose progressive actions would undoubtedly be acceded to by an appreciative public.

COMPARATIVE DATA ON BOULEVARDING AND TREE-PLANTING.

City or town.	Mode of carrying out work.	Cost of tree-planting each per tree.	Cost of boulevarding per lin.ft.	Cost of maintenance per sq. yd.	Distance of feet apart.	Distance from property line.	Remarks.
Seattle	Private enterprise	No information	No information	No information	—	—	Not under jurisdiction of any city department
Edmonton	Local improvement	$1.75 (including protection)	$1.80 to $2.75	4 cents	10 ft.	15 ft.	Not under jurisdiction of any city department
Portland	Local improvement and revenue	$1.05 to $5.00	35c. to 95c. per sq. yd.	No information	40 ft.	9 ft.	Not under jurisdiction of any city department
Nelson	Private enterprise	90c.	No information	No information	20 ft.	12½ ft.	Not under jurisdiction of any city department
Minneapolis	Local improvement assessed over a term of 3 years	$6.00	—	No maintenance done by city	40 ft.		Boulevards roughly graded by works dept.
Calgary	Local improvement	75c.	40c. per sq. yd.	No record kept	12 ft.	11 ft.	Trees grown in own nurseries
Chicago	Private enterprise and park commission	$5.00	$1.30 per sq. yd.	No record kept	12 to 50 ft. according to variety		
New Westminster	Local improvement	—	35 cents	No record kept	Varied	Varied	
Kamloops	Revenue account	$1.00	40 cents	No record kept	10 ft.	—	Work not organized
Victoria	Local improvement	$1.00	—	—	30 ft.	Varied	

PRESERVATIVES PROLONG LIFE OF POOREST WOODS.

As a result of the many inquiries in regard to the preservative treatment of fence-posts, the Forestry Branch, Ottawa, has now issued a circular on this subject which can be had by applying to the Director of Forestry. The various methods described of treating the posts with the preservatives are all illustrated by diagrams, and the apparatus required is simple and costs little.

The great advantage of these treatments is that they keep even cheap woods free from decay for from 10 to 15 years. Many kinds of wood found in wood lots will last, when used as posts, only four years or thereabouts; after treatment, such as described, they last twice or three times, even four times, as long.

Creosote, which costs in Canada, from 10 to 25 cents a gallon, is the best preservative. When boiling-hot creosote is applied with a brush—a paint brush or whitewash brush, for instance—to the butts of well-seasoned posts from which the bark has been removed, it sinks into the wood for a distance of about a quarter of an inch. This should add at least 10 years to the life of a post made from a non-durable wood, such as poplar, balsam, fir or spruce. This is not the best method, but it is the simplest and, on a small scale, probably the cheapest. Other methods require that the posts be kept covered in tanks of hot creosote for a longer or shorter period.

Besides lengthening the life of the post, the preservative treatment also tends to reduce the cost of the posts in another way, for, as cheap local woods can be used, the first cost and the cost of transportation are usually much lower than for cedar, oak or tamarack. Moreover, as posts will need to be set less often, the proportionate cost of setting the post will be less. Taking into account all the items that go to make up the cost of the post, and comparing this with the number of years it will last, it will be found in the majority of cases, to be much less for treated posts.

FINISHED STEEL PRODUCED IN CANADA IN 1912.

THE figures collected by the Statistical Bureau of the American Iron and Steel Association show that the total production of steel in Canada in 1912 was 853,031 long tons; 207,569 tons being bessemer, 645,062 openhearth and 400 tons special steel. The openhearth steel was all basic. The production included 4,238 tons of direct castings from bessemer steel and 28,001 tons from openhearth steel. By provinces, Nova Scotia produced 416,313 tons and Ontario 417,634 tons, the remaining 19,084 tons being made in Quebec and British Columbia.

The production of steel ingots—including direct castings—in Canada has been as follows for nine years in long tons:—

	—Bessemer—		—Openhearth—		Total
	Tons.	Per cent.	Tons.	Per cent.	tons.
1904. . . .	42,738	28.7	106,046	71.3	148,784
1905. . . .	164,488	40.8	238,681	59.2	403,449
1906. . . .	219,791	38.5	347,778	60.1	570,889
1907. . . .	202,268	31.3	440,936	68.2	646,754
1908. . . .	108,433	21.3	401,119	78.7	509,957
1909. . . .	182,304	27.0	496,142	73.0	678,751
1910. . . .	199,570	27.0	542,354	73.0	741,924
1911. . . .	189,797	24.0	601,074	76.0	790,871
1912. . . .	207,569	24.4	645,062	75.6	853,031

The small production of special steels is included in the totals. In most of the years given it was only a few hundred tons, except that in 1906 and 1907 it reached 3,320 and 3,550 tons, owing to the inclusion of some experimental work.

Finished Iron and Steel.—The production of all kinds of finished rolled material in Canada in 1912 was 861,224 tons, 109,012 tons being iron and 752,212 tons steel. The total was greater than that for 1911 by 79,300 tons, or 10.1%. Of the total, rails were 423,885 tons; structural steel and wire rods, 64,082; plates, sheets, bars and other forms, 373,357 tons. Ontario produced 418,346 tons, Nova Scotia, 337,466; Quebec, 88,172, the remaining 17,240 tons being from New Brunswick, Alberta and Manitoba.

The production of rails and the total make of all kinds of finished iron and steel in Canada for 10 years has been:—

	Rails.	Total.
1903	1,243	120,516
1904	36,216	180,038
1905	178,885	385,826
1906	312,887	571,742
1907	311,491	600,179
1908	268,692	496,517
1909	344,830	662,741
1910	366,465	739,811
1911	360,547	781,924
1912	423,885	861,224

In 1912 there were 31 plants which made steel ingots or castings or rolled iron and steel into finished forms. Six of these were in Nova Scotia, eight in Quebec, 13 in Ontario, one each in New Brunswick, Manitoba, Alberta and British Columbia. Two new steel-casting plants were built during the year in Quebec and two in Ontario; at the close of the year a new merchant bar mill was under construction in Alberta.

Miscellaneous.—Other production of finished material in Canada in 1912 was as follows, compared with the previous year:—

	1911.	1912.	Changes.
Forgings, tons	18,832	22,415	I. 3,583
Rail joints	......	52,157	......
Nails, kegs of 100 lbs. ..	652,861	788,190	I. 135,329

The production of rail joints was not reported in 1911. Of the forgings made in 1912 there were 21,548 tons of steel and only 867 tons of iron. All the nails made were of steel.

GAS WELLS AT MEDICINE HAT.

IN order to show exactly what has been done in Medicine Hat, Alta., in the way of drilling gas wells, the city engineer's office has furnished a statement of the number of wells operated or in construction, with the depth of same, name, open flow in cubic feet per 24 hours, year drilled and rock pressure in lbs. per square inch. This information is the first of the kind yet issued, and was prepared at the request of the Board of Trade, the data being as follows:—

No. of well.	Depth, feet.	Open flow, cu. ft., 24 hours.	Year drilled.
1	1,000	2,225,000	1904
2	1,000	3,000,000	1906
3	1,000	2,500,000	1909
4	1,000	2,500,000	1911
5	1,200	4,000,000	1911
6	1,000	2,000,000	1908
7	1,200	2,500,000	1911
8	1,300	3,000,000	1913
9	1,002	2,200,000	1913
10	1,100	2,800,000	1909
11	1,050	2,900,000	1910
12	1,202	2,300,000	1913
13	1,202	2,100,000	1913
14	1,075	3,300,000	1913
15	1,075	2,900,000	1913
16	1,033	2,500,000	1912

NOTE—In the case of each the rock pressure is given as 550 pounds.

In addition, drilling has been started on Well No. 17, and the Medicine Hat Brick Co. has a well 1,050 feet deep. For some years the Canadian Pacific Railway has had a gas well on its right-of-way near the station, and work has just been completed on a second well for the Canadian Pacific Railway, the depth, open flow and rock pressure averaging with the other natural gas wells in this city.

The above twenty wells are all in the city limits, and it is notable that there has been no appreciable diminution in the pressure or flow from the same, notwithstanding the increased consumption of natural gas, due to the rapid industrial expansion of Medicine Hat.

This list does not take into account the string of wells being drilled by the Hunt Engineering Co., for the $2,500,000 plant of the Canada Cement Co., which will also purchase its water supply from this municipality.

CONSTRUCTION AND MAINTENANCE OF ROADS WITH REFERENCE TO METHODS PRACTISED IN SCOTLAND.

By Robert C. Muir, C.E.

FOR convenience the subject is divided by the writer into paved roads and macadamized roads; and let it be stated at the outset the most important feature of both is the foundation. One may make the surface of the very best material procurable, but unless there is a good, sound and well-drained foundation it is of no avail.

Of the paved roads granite, or other stone setts and pitchers, wood blocks and asphalt will be dealt with.

The first cost of any paved road is comparatively heavy; therefore, before deciding whether to convert a macadamized road into a paved road the necessity of the case must be investigated. As a general principle, if a conversion is to be made, or if a new roadway is to be constructed, in a neighborhood where there is a very heavy traffic, but dwelling houses and stores do not abut, a granite or whin paving is used; otherwise wood or asphalt is used. If a macadamized surface has to be renewed as frequently as once in two years and to be patched intermittently, a stone paving will prove more economical. If traffic weight is to determine the point, 250 tons per yard width per day of sixteen hours may be taken as the limit for macadam. In laying down the two-year-old rule, town roads are particularly in view, where the cost of cleaning, watering, etc., has to be contended with to a greater degree.

At this stage it may be convenient to consider the life and cost of granite sett and wood paving. In England and Scotland the Local Government Board grant loans for the following periods:—

Granite Setts	20 years
Hardwood	10 "
Soft wood	7 "
Concrete foundations	20 "

Under average conditions of traffic, granite setts will wear for thirty years, if not more; wood paving would wear for at least fifteen years. There is still a good value in granite setts at the end of thirty years, and they can be lifted and redressed. The seven-year period for soft wood is perhaps rather short, and if one calculates the interest and annual instalment for repayment, and adds to them the cost of repairs—which becomes increasingly heavy as time goes on—it will be found that the financial operation is not a profitable one. The repairs may vary from 5 cents to 25 cents per square yard per annum. Maintenance contracts extending over twenty years, at 15 cents per square yard per annum, the paving to be left in good condition at the end of that time, are in force, and have been lately renewed in many towns.

Before commencing any reconstruction of roads due notice should be given to gas, water and other authorities having mains in the road, so that they may have the opportunity of relaying or examining the same; otherwise the new work may probably be pulled up for renewal, etc., of pipes soon after it is finished.

Stone Paving.—The foundation should consist of a bed of 6 to 7½ inches of Portland cement concrete (6 to 1), the depth varying to traffic weights and the depth of stone used. All recently filled-in trenches should be dug out to a depth of 6 inches below the ordinary formation level, and for a width of about 6 inches to 9 inches in each side of the trench, and splayed back to an angle of 45 degrees; and then filled in with concrete. If a wet or clayey ground be present there should be a sub-bed, tightly rolled, of 4 to 6 inches of fine furnace ashes, to keep the clay down and the concrete dry. There is nothing better than fine ashes to stifle clay.

The paving stone most to be desired is a hard and tough material that will resist wear, and at the same time not become polished by the traffic. In Scotland and England the Aberdeen and Enderby granites have given the best results.

A good size for pitchers is about 4 inches wide, 8 inches long and 6 inches deep, and for setts, 4-inch cubes or 4 by 4 by 5 inches deep, the stones to be carefully dressed and squared with no greater discrepancy in depth than ¼ inch.

The 4 by 4 by 5-inch setts are to be preferred, laid on a 1-inch sand bed in courses at an angle of 45 degrees, with the channel courses, which generally consist of 12 by 6-inch flat stones or three courses of setts, the setts grouted with Portland cement grout (2½ to 1). A pitch joint gives a slightly quieter paving, but the edges of the stones are more liable to be chipped off. Keep the traffic off the work until the concrete and jointing are set.

Wood Paving.—The same remarks as to foundation apply as in the previous case. The most usual depth of concrete is 7½ inches, with 1½ inches of Portland cement rendering (2½ to 1), finished with the steel trowel to a true and smooth surface, washed ¼-inch granite or whin chippings and sand being used, the rendering to be absolutely hard and dry before the blocks are laid.

Jarrah, karri and blackbutt, also English oak in "prismatic" form and creosoted, are hard woods which have given good results. In these woods the most useful size of block is 3 by 9 by 4 inches deep, and in creosoted deal 3 by 9 by 5 inches deep. Jarrah, karri and blackbutt should be laid with close joints and dipped one side and one end in a boiling mixture of pitch and creosote oil. There is no necessity to dip the "prismatic" oak blocks if creosoted, except the channel courses, the bituminous grout following down well between the joints. Creosoted deal blocks are generally laid with a slight joint, often kept open by laths 1 inch deep and 1/10 inch wide, laid at the bottom of the courses.

Adequate expansion joints are provided next to the curbs, but there is very little expansion or contraction in the "prismatic" oak paving, and not so much in the creosoted deal as in the jarrah, karri or blackbutt.

Round gravel for surface dressing the paving should not be used; it is driven into the blocks by the traffic and destroys the fibre.

Asphalt Paving.—Asphalt gives a good wearing surface; it is clean, healthy and durable; its great fault is slipperiness. The rock asphalt, laid in the form of powder on a concrete foundation is compressed with heated irons into a homogeneous mass. When laid 2¼ inches thick (compressed) it will last fifteen years under heavy city traffic. The cost is about $3.50 per square yard, including foundation. The cost of repairs, averaged over the whole life, is 12 cents per square yard per annum. The mastic asphalt, melted with a flux of pitch and about 20 per cent. of clean coarse grit added to give a foothold, and laid in a mastic state, is not so durable as the compressed powder, and is sooner acted on by the sun.

Macadamized Roads.—In country roads we are generally able to deal with the drainage of the foundation of

the surface by means of the side ditches, but in towns it is necessary to provide a sysem of sub-drainage and lead the water away by means of pipe drains. The surface water (as from the paved roads also) is dealt with by gullies connected to the sewers, the number of gullies depending on the gradients of the roads.

The roadway should be of the same strength all over; that is to say, in excavating (or filling in) for the foundation, from it to the contour of finished surface. When roads are curbed and channelled they should be laid on a bed of 6 inches of Portland cement concrete. A good foundation is a layer of clean ashes or broken stone 6 inches in depth; on this a second layer, consisting of hand-set stone (whin or freestone) 8 inches in depth set on edge in the manner of a rough pavement. Over this layer a coating of broken stone should be laid, so as to fill up the intersticies and form a smooth surface; each layer to be thoroughly consolidated by a 10-ton steam roller. No round gravel should be used; it will work its way up through the metalling when thin, and it is not at rest in the road when under heavy traffic.

The metalling for finishing the roadway should be of the very best quality obtainable, tough and hard, broken so as to be as cubical as possible, and so that every stone shall pass through a 2½-inch ring in any direction; the same to be spread in two coats.

The first coat having been uniformly spread over the whole roadway should be rolled by a 10-ton steam roller until consolidated; the second coat should then be uniformly applied and consolidated, and the whole surface receive a coating of fine chippings of the same stone as the metal. The chippings should be screened through a ¾-inch mesh and to include the fine material down to dust. The roadway should be well watered and rolled until thoroughly consolidated.

On completion it should present a hard and perfect surface, true in level and cross section, and coated with a thin layer of ½-inch chippings of similar material free from dust. The depth of metalling will vary according to traffic, but 6 inches is recommended for first-class roads.

Instead of water-binding method just described, the use of bituminous binder has recently been revived. The principle is to spread it about ¾-inch thick, lay the metal thereon, and squeeze the binder up between the stones by rolling. In heavy coating, the operation is performed in two applications. Good weather is necessary for the work, and it requires special care, the cost is little less than tarred macadam.

The results of the use of a bituminous binder are less wear and tear and less mud and dust, consequently a longer life.

The subject of tarred macadam is now receiving considerable attention. Its utility greatly depends on the ingredients, their treatment and mixing, concerning which space does not permit of writing, but which will be explained fully in a paper to be published later, in connection with the good roads movement in Canada. When it is said that this material will stand heavy traffic, what is meant by it? It is not expected to wear like stone or wood paving. If the comparison is with ordinary macadam, then the process of bituminous binding will not stand heavy traffic either. When tarred macadam is used, the writer is in favor of a bottom course of 4 inches of tarred 2-inch stone and a top layer of 1½ inches of fine, rather than finishing the surface with larger stones; I believe that this system is better for repairing purposes. A tandem roller is best for this work. The traffic should be kept off all classes of macadamized roads while they are being constructed, and until the surface has dried out.

Taking into consideration the items of utility and cost and the facilities of construction and repair, I am of opinion that of macadamized roads, one constructed with good stone (waterbound) on a proper foundation, and the surface properly coated with hot coal gas tar, is the best.

The system of tar spraying roads by machinery has facilitated and reduced in cost one of the greatest boons conferred upon the users of macadamized roads. It lessens wear and tear, prevents damage by suction of pneumatic tires, reduces dust to a minimum, reduces mud, and generally increases the life of a road.

Watering is unnecessary for maintenance on tarred surfaces, and when watering is resorted to on ordinary macadam the spray should be fine.

In repairing or patching ordinary macadamized roads, the surface of the defective place should be picked up, the old material removed, fresh stone laid and rolled in. The use of a little fine tarred stone will be found useful as a binder in dry weather.

In recoating, the old surface should be scarified not too deeply, the fine material and such of the old stone as is usuable removed, and the new stone be then applied.

Camber.—If the difference in level between the centre and side of a road were properly apportioned instead of making the middle too flat, there would not be so much complaint of excessive camber. The writer would suggest 1 in 25 for macadam, 1 in 36 for soft wood, and 1 in 45 for whin or granite setts, hard wood and asphalt paving.

INTERNATIONAL ELECTRICAL CONGRESS, SAN FRANCISCO, 1915.

The International Electrical Congress is to be held at San Francisco, September 13th to 18th, 1915, under the auspices of the American Institute of Electrical Engineers by authority of the International Electrotechnical Commission, and during the Panama-Pacific International Exposition. Dr. C. P. Steinmetz has accepted the honorary presidency of the Congress. The deliberations of the Congress will be divided among 12 sections which will deal exclusively with electricity and electrical practice. There will probably be about 250 papers. The first membership invitations will be issued in February or March, 1914

Attention is drawn to the distinction between this Electrical Congress and the International Engineering Congress which will be held at San Francisco during the week immediately following the Electrical Congress. The engineering congress is supported by the societies of Civil, Mechancial and Marine Engineers and by the Institutes of Mining and Electrical Engineers, as well as by prominent Pacific Coast engineers who are actively engaged in organizing it. This Congress will deal with engineering in a general sense, electrical subjects being limited to one of the 11 sections which will include about 12 papers, treating more particularly applications of electricity in engineering work.

The meeting of the International Electrotechnical Commission will be held during the week preceding that of the Electrical Congress.

THE PROGRESS OF CANADIAN PACIFIC RAILWAY IRRIGATION IN ALBERTA.

THE engineering features of the irrigation projects of the Canadian Pacific Railway in Southern Alberta were described in detail by Mr. A. S. Dawson, Chief Engineer, Department of Natural resources of that company, in July 18th and July 25th, 1912, issues of *The Canadian Engineer* (pp. 192-225). For a history of irrigation in the West dating from 1892, and for an outline of the developments of more recent years, particularly the above development in the Bow River Irrigation Block, containing 3,097,000 acres, the reader is referred to this article.

The block divides itself naturally by topography into three sections of approximately 1,000,000 acres each. The Western Section enterprise was begun in 1903 and completed in 1910, constituting a diversion from the Bow River near Calgary, and comprising approximately 1,600 miles of canals and ditches. The Central Section will receive its supply through the enlargement of a portion of the trunk system through the Western Section. The Eastern Section utilizes the Horseshoe Bend on the Bow River, about three miles southwest of the town of Bassano, the water for irrigation purposes being supplied through an intake at this point, and acquiring distribution through a system of canals, reservoirs, etc., the total mileage of canals and ditches reaching 2,500. Innumerable drops, headgates, flumes, syphons, bridges, etc., to a large extent built of reinforced concrete and brick, are included.

To provide a sufficient volume of water, what is known as the "Bassano Dam" is constructed at Horseshoe Bend. It is a composite structure consisting of an earthen embankment some 7,000 feet in length, with a maximum height of 45 feet, a maximum width at base of 310 feet and a uniform top width of 32 feet; and a reinforced concrete spillway with a clear length between abutments of 720 feet, and a weir length of about 600 feet. It has a maximum height of about 400 feet to the overhead crest, and contains about 40,000 cu. yds. of concrete, with 1,250 tons of reinforcing steel. At its easterly end are situated the canal headgates, consisting of five openings, each of 20 feet, controlled by Ransome and Rapier's "Stoney" sluices, directing the discharge of 3,800 feet per second through a canal of 90 feet bed width, which discharges into a reservoir five miles distant, formed by an earthen dam 1,280 feet in length, and 35 feet maximum height. From this point a canal runs in a northerly direction distributing to about 90,000 acres. Another canal heading eastward branches out into distributaries taking care of the remaining portion of the Eastern Section.

Among the many interesting features, the one which probably stands out as the chief one, is the Bassano Dam, the gigantic proportions of which are merely mentioned in the above. Mr. Dawson's article is descriptive of the whole project, and a re-reading of it in conjunction with the following new information is advisable to adequately acquire an understanding of the development to date.

The construction of this Bassano Dam across the Bow River has been completed. As a result of its opening the Eastern Section, and its million acres of prairie land previously looked upon as of little or no use for agricultural purposes, is now placed under irrigation and will prove as productive as any other portion of the Dominion.

Fig. 1.—General View of the Bassano Dam, Headgates and Surroundings, Bow River, Alberta.

The gigantic work which has entailed the expenditure of several millions of dollars has been carried out under the supervision of Mr. J. S. Dennis, assistant to the president and head of the Department of Natural Resources.

About three years have been spent in this work; it is probable that the remaining portion can be built during the year 1914. The greater part of the earthwork for the canals, aggregating twenty million cubic yards, has been completed and operations well advanced on the principal structures. The remaining work to be done consists largely of placing over a thousand small structures, mainly wood, scattered over the irrigable tract covering the greater part of 2,000 square miles. A general review of the works as planned and constructed indicates that the location has been studied out on the ground with care and that the resulting position and alignment is in general superior to that found on most of the irrigating works of North America. The structures have been considered and planned with skill, evidently utilizing the experience and avoiding many of the errors of earlier similar works in the United States. The designs show careful study of the physical factors and an elaboration of detail well in advance of other works and embodying the best modern ideas. While, as in many engineering operations, there

may be individual differences of opinion, and possibility of criticism of details, yet it is evident that safety and permanence has been the primary consideration. Reviewing the structure as a whole, it may be said that, while elaborated with high engineering skill, there has been a proper regard for economy in construction and in the future maintenance of the system.

The water supply is derived, as stated, from Bow River, being protected by compliance with the necessary legal requirements. The quantities, as shown by the records of the Dominion Government, are notably large, the river receiving the drainage from over 5,000 square miles above Bassano. It has a heavy spring flow, the highest stages being reached between June 15th and August 15th, and thus furnishing an ample quantity for conveyance through the main canal to the storage reservoir located within the irrigable tract. This provision of storage for a part of the irrigable area and in the vicinity of the farms is notable as an assurance against certain classes of operation troubles.

The low water surface in Bow River is raised approximately 40 feet by the Bassano Dam, located 83 miles east of Calgary. This is built with regard to economy of material and of the so-called "Ambursen type" with heavy floor on the bed of the stream, protected by suitable cut-off walls. Upon this are erected buttresses carrying a sloping deck with apron, the whole designed to pass 100,000 cubic feet of water per second with extreme height of 13 feet above the crest. The concrete portion of the dam is prolonged westerly within the Horseshoe Bend by an earthen dyke with maximum height of 45 feet and length of 7,000 feet, as mentioned above, containing about 1,000,000 cubic yards. At the time inspected, the dam was approaching completion but the final closure had not been made. There was every indication, however, that this could be successfully accomplished within a few days. The headgates form a part of the dam and are practically completed.

Extending easterly from the dam is the main canal, five miles in length, partly in a deep cut of 70 feet bottom width and which, being made in earth of somewhat treacherous character, has given considerable trouble. In this respect it is comparable with a number of similar deep earth cuts which have been made and successfully maintained under similar conditions on canals in Montana and adjacent areas. This cut will presumably continue to be a source of annoyance and some expense, but is simply one of the many difficulties which appear to be unavoidable. Beyond the eastern end of this cut, the main canal, the capacity of which is 3,800 cubic feet per second, divides, the smaller portion, with bed width of 30 feet and capacity of 800 cubic feet per second, turning toward the north, while the larger branch, with capacity of 2,200 second-feet, continues toward the east. On the northern branch and its subdivision are many important structures, such as drops and flumes, but the larger number of these is on the eastern canal, and its subdivisions.

The most notable of the canal structures is the Brooks Aqueduct, 10,000 feet in length, with capacity of 900 second-feet, crossing a broad low depression. At the time visited, this was in the initial stages of construction, the concrete pedestals being in place and the wooden forms for pouring a portion of the aqueduct being partly erected. The design of this aqueduct is novel, but evidently based on careful study and with a view to permanence and economy of material. Practically all of the larger structures in the Eastern Section have been, or are being built of concrete, the chief exception being several large wooden flumes, built in localities where it is evidently more economical to use wood than concrete and steel. The drops in the canal are of substantial design. They are of concrete and embody features found to be necessary for their permanence. There is a considerable number of high earth fills built in place of flumes. It is obvious that great care must be used in wetting these and in bringing them into service, but there is every reason to expect that with proper precaution these raised portions of the canal will be permanent and can be maintained at less expense than the ordinary timber conduits. The smaller structures for distributing water to the farms or groups of farms, numbering over a thousand, have not yet been put in place, but the parts are being assembled at various lumber yards from which they will be distributed as needed. It is believed that good practice justifies

Fig. 3.—View from Westerly End of Dam.

the building of these hundreds of smaller structures of wood, even though they must ultimately be renewed within ten or twelve years. In some of the projects in Montana concrete has been used for this purpose, especially where railroads or other means of transportation are available and gravel could be had nearby. It is found, however, that as a new country develops, it is necessary to make a number of changes in the distribution system with the result that by the time the smaller wooden structures need renewal, there exists such a difference in methods and of transportation possibilities that the wood can then be replaced to advantage with concrete. At the same time the plans can be modified to suit the developments which have taken place. Thus, it results, as above

stated, that the use of wood in these smaller structures is in accordance with good practice and sound economy.

The area for which water is being provided, in general, is undulating and with notable slopes towards Bow and Red Deer Rivers. There is a number of distinct drainage lines traversing the country and the topography, as compared with that of most of the plains region, is favorable for a relatively rapid run-off of excess water. There is a considerable number of partly closed depressions, such as are characteristic of all glaciated regions. Provision has been made for draining many of these or for connecting them up, affording outlets for the surplus waters. Thus the main drainage system has been provided in part by nature and in part by artificial means. It is probable that as irrigation progresses and water is used lavishly, as is habitually done by the new-comers, extensions and possible deepening of some of the drains will be necessary. In this connection experience has shown that, as far as possible, plans should be made in advance for delivery of water by rotation, allowing certain distributaries to be periodically dry so as to reduce the seepage of water from them and to permit the irrigated lands to be relieved from excessive saturation. The first problem under the prevailing climatic conditions is first to induce the farmer to exercise forethought and to use water at the right time; the second, and even more difficult, is to get him to appreciate the danger of using too much water. He is apt to assume that if a little water is a good thing, a large quantity is better, whereas, the larger quantity may be injurious to his crop and to his neighbors' fields, and ultimately may necessitate large, and otherwise unnecessary expenditures for deepening and extending the drains. In order to prevent the occasion for these large expenditures for drainage arising in the future, arrangements are made on many of the new irrigation systems to deliver water on a measured basis, a certain minimum quantity being obtained at a flat charge assessed on all irrigable lands. For example, 50c. or $1 is to be paid, usually in advance, whether the irrigable land receives water or not, and for this, say, one acre-foot can be had. This minimum is set at the amount which is considered to be necessary for the production of the average crop under ordinary conditions, but it is not enough to result in water-logging the soil and in the consequent demand for drainage. For all quantities in excess of this minimum an additional charge is made and collected in advance. The result is that the irrigator, being called upon to pay out his money when he demands more water than minimum, considers very carefully as to whether he really needs the water. As a rule, he concludes that he can get along with a smaller amount than he otherwise would deem necessary. Experiments have shown that the largest crop yields are obtained with the minimum amount of water applied, consistant with suitable plant growth, and that while many crops are tolerant of considerable amounts of water yet the yield is reduced in quantity and quality of such excessive application. The production of the best crops is, therefore, very closely joined with the conditions of carefully measured supply and the consequent avoidance of the necessity of incurring large expenditures for drainage of the irrigated lands. The plans already made and largely executed for the main drainage lines appear to make ample provision for future contingencies. If the operation of the distributing system is carried on in accordance with the principles above noted, it is probable that any considerable large future expenditure can be avoided.

Fig. 2.—Massive Abutment and Pier Construction, Bassano Dam.

The works have been advanced to a point where it is assumed that the final cost will be about $20 per acre of land irrigated, for approximately 440,000 acres. This may be exceeded somewhat, but even if the cost rises to $25 per acre, or even more, it will still be less than the average of similar work executed in the United States. There the prices of recently constructed large systems, with storage and with principal structures of concrete, average from $40 to $50 per acre irrigated. The relatively low cost of the Eastern Section, compared to the permanence of the work, is due to the large extent of the area irrigated and the simplicity of the entire system. It is understood that the preliminary surveys for the work on the Eastern Section of the Irrigation Block, showed as originally reviewed, a cost of approximately $16 per acre for 540,000 acres. Later it was found that the irrigable acreage must be reduced to about 440,000 acres, with accompanying increase in cost per acre. There is a probability at present that a new classification made on a more strict basis, taking the detailed surveys of each quarter-section, may cause a further shrinkage of the irrigible area with a corresponding increase in acreage cost. Whatever this cost may ultimately be, it is evident that the works are well worth the expenditure and that, as stated, the cost per acre will be less than that of most well-built large systems in the States to the south. In explanation of the fact that the final cost will exceed the preliminary estimate of $16 per acre, it may be stated that there has been a general advance in costs of construction, accompanied by a demand for a larger number of permanent structures and greater elaboration of detail. The greatest factor, however, in increasing the acreage cost is that due to the general decrease of acreage upon which the cost must be distributed, due to the more rigid exclusion of small scattered tracts of land considered as non-irrigible. The era of low costs in irrigation construction has passed. Throughout the country the same condition prevails, namely, that the estimates of the engineers as to what might have been accomplished four or five years ago under the then existing conditions, are being to-day exceeded in the actual operations. Engineers, like other professional men, are not prophets and must base their figures upon the experience of the past with such allowance as have proved wise; the increase in cost such as has taken place could not have been safely predicted.

The Eastern Section includes a million acres, out of which there has been selected approximately 440,000 acres, lying in an altitude of from 2,300 to 3,300 feet, and which may be irrigated from the system as planned and nearly completed. The tract as a whole is a part of the Northern Great Plains, the surface of which has been modified by glacial action, with resulting heavy underlying deposits of sand and gravel, and particularly of clay, interspersed with large and small boulders. The resulting top soil on the glacial deposits is frequently loamy, usually very rich, and in places slightly sandy. Everywhere seen it is of suitable depth and quality for excellent crop production. The native vegetation, largely of various grasses, grows luxuriantly wherever there is an adequate supply of moisture.

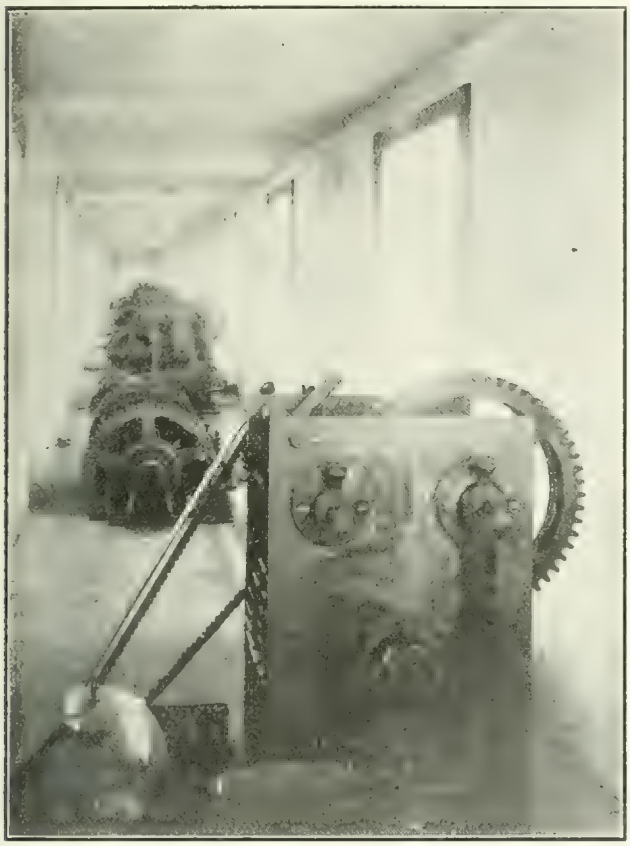

Fig. 4.—Interior of Power House for Operation of Headgates.

Contour maps have been prepared covering the lands which can be reached by the canals. In the study of these maps the rougher, or more gravelly tracts have been eliminated as non-irrigable, leaving for consideration only those portions which appear to have an ample depth of good soil. There is no doubt as to the capability of these irrigable areas to produce highly remunerative crops if properly handled.

The climate, owing to the lower altitude of the Eastern Section, is somewhat more favorable than that of the Western and the growing season is longer. It appears to be peculiarly well adapted to mixed farming or dairying with raising of forage crops.

It may be stated that, taking this Eastern Section as a whole, with its water supply, soil, engineering plans and construction, it stands well in the front of similar enterprises. Its future success, as far as these are concerned is assured. The great problem now is that of securing a prosperous and contented agricultural population.

RAILWAYS IN THE MALAY PENINSULA.

The total mileage of railway lines open to traffic in British Malaya, including leased lines, on December 31st last was 734 miles, an increase of 175 miles, and as there were 92 miles of sidings, the total mileage of railroad in operation at the close of the year was 826. The expenditure on new lines under construction and surveys was £529,027, and on special services £273,077—a total of £802,104. For the current year the federal estimates provide for an expenditure of £2,168,-831 on railways against £1,513,171 in 1912, the amount for special services on capital and revenue accounts and for construction being estimated at over £1,500,000. It will thus be seen that this important department is endeavoring to keep ahead of the trade requirements of the country, and the encouraging development that has occurred in the eastern State of Pahang during the past year is one evidence of the expansion that follows railway extension. The growth of trade in the other States has led to the issue of instructions for a survey of the Port Swettenham-Kuala Lumpur line with a view to the duplication of the line. A survey has been begun on the Port Dickson line for its improvement. The duplication of the line between Singapore and Bukit Timah is begun, and preparations are in progress for other extensions in the Federated Malay States. One of the more important works in contemplation is the construction of a bridge across the Straits of Johore, about three-quarters of a mile wide. In the State of Kelantan marked progress is being made with the line which eventually will link up the British Malaya and Siamese railway systems, and the general manager expects to be able, by March next, to transport goods from Tumpat on the coast to Tanah Berah on the Kelantin River. Orders have been placed for the purchase of a tug and lighters for the transport of goods from steamers to the railway wharf at Tumpat. Mention of these matters gives the opportunity of calling attention to the enormous changes in progress in a region which, a comparatively few years ago, was practically unknown to white men. The linking up of the Malayan and Siamese Railways will probably be followed by connections with Burma and Indo-China, and it is not too sanguine a view to contemplate the time as not very remote when it will be possible to travel by rail from Singapore in the extreme south to Burma or China. In Malaya, where British influence is paramount, the work certainly proceeds apace.

A modification of the usual method of estimating phosphorus in low-phosphorus steel is given in *Journ. Soc. Chem. Ind.*, July 31st, 1913. The yellow ammonium-phosphomolybdate precipitate, obtained from the steel in the usual manner, is washed with 1 per cent. nitric acid until free from iron, and the nitric acid is washed out by means of 1 per cent. potassium-nitrate solution until the washings are free from acid. The filter and precipitate are then transferred bodily to a 200 c.c. flask, 20 c.c. of $N/10$ sodium-hydroxide solution and 2 drops of phenolphthalein are added, and the excess of alkali is titrated with $N/10$ hydrochloric or nitric acid until the last drop completely removes the pink color. The following reaction takes place:—

$$(NH_4)_3PO_4.12MoO_3 + 24\ NaOH =$$
$$(NH_4)_3PO_4 + 12\ Na_2MoO_4 + 12\ H_2O.$$

Hence, 1 gram of phosphorus is equivalent to 31 grams of sodium hydroxide, or each c.c. of $N/10$ sodium hydroxide is equivalent to 0.000129 gram of phosphorus. Thus, when working with 1 gram of steel, the percentage of phosphorus is obtained by multiplying by 0.0129 the difference between 20 and the number of c.c. of acid used in titrating the excess of alkali. The method has been found to give accurate results, in excellent agreement with those obtained by the gravi-metric method.

COMMERCIAL LINSEED OILS.*

By A. Gordon Spencer, B.A., M.Sc.,
Chief Chemist, Canadian Inspection and Testing Laboratories, Limited.

IT was about the 12th century that the essentially exclusive properties of linseed oil were discovered and developed by the monks who used to occupy their leisure time in oil painting, in illuminating theological treatises and writings before the art of the modern printer was developed, or possibly even thought of. Their early experiments and patient investigations showed them that the oil extracted from the flax seed was much superior as regards ease of extraction and preparation as well as in beauty and durability of the finished painting. Previous to this date; in fact, before the Christian Era, there are records and descriptions of the medicinal properties of certain decoctions of linseed and of the resultant oil. Its actual commercial use, however, did not begin until the later period above mentioned and since that time no substitute has yet been found which possesses all of the properties of linseed oil which to-day make it so valuable not only to the artist but to the painter, printer, as well as to many manufacturers. Many claims are made for various so-called linseed oil substitutes, that they are fully equal to, if not better than, linseed oil, but so far as we are aware their claims have not yet been completely proven.

Uses of Linseed Oils.—Linseed oil in some form or other plays a prominent part in the manufacture of linoleum and oil cloth, in dressing of leather, in the varnish for patent leathers and carriage tops, in oil-clothing, in printers' inks, certain kinds of soap, rubber substitutes, etc., etc. Its principal use, however, is in the various branches of the painting and decorating trade.

Preparation.—Linseed oil is obtained from flaxseed by grinding and extraction. In the early stages of the industry the seed was crushed and ground and the oil extracted by pressure at ordinary temperatures. The resulting oil contained no "foots," was quite light in color and was of excellent quality for immediate use. The percentage of oil extracted, however, was not very high, and a large proportion was left in the oil cake. By cooking or "tempering" the ground seed with steam the plant cells are broken up more thoroughly and a more complete extraction of the oil is obtained, so that at the present time practically no cold-pressed oil is made, but all the oil is hot pressed. The product differs from the cold-pressed oil in that it contains considerable gummy mucilaginous matter commonly termed "foots," part of which is subsequently removed by settling and filtering before being stored as raw linseed oil.

A small quantity of oil is also obtained by the use of solvents with subsequent evaporation of the latter. This oil, however, is not as good as that obtained by pressure and the residual oil cake which in the case of the pressed cake always commands a good market price as a stock food, is of very little use for this purpose, as one of the chief food constituents, viz., the oil, has been almost completely removed. It is also said to be found unpalatable on account of the last traces of the solvents not being completely removed.

*Paper presented before the local section of the Society of Chemical Industry in Montreal, December 12, 1913.

Raw Linseed Oil.—This is the oil as it comes from the storage tank and which is used by the consumer without any further preliminary treatment. Its value to the paint and varnish maker, as well as in the other industries in which it is used, is due to its characteristic property of drying quickly and completely to a hard, tough, elastic and durable film upon exposure to the atmosphere. The nature of the film produced upon drying depends not only upon the maturity of the seed, as well as its freedom from other seeds; but also upon the carefulness with which the oil is processed and stored. It has been found that seed from two to six months old gives a less viscous and turbid oil than fresh seed. Mature seed gives a lighter oil than young seed. The yield of oil is also higher in the former. According to Ennis (Linseed Oil and Other Seed Oils, p. 220 footnote), there is a slight (though progressive) improvement in oil from seeds derived respectively from the American Northwest, India, Morocco, Holland and the Baltic, evidenced by the higher iodine absorption value. The Calcutta seed is stored in pits dug in the ground and contains a large amount of clayey dust; there is very little other impurity. It produces a very light oil, well adapted for varnish purposes. Bombay seed is very difficult to grind, but makes a fine oil, which, however, cannot readily be "bodied down" by heat.

One of the most important requirements, however, in the production of a good raw oil is a long period of storage before being shipped and consumed and this applies especially to hot-pressed oil. The initial filtration of the oil as it comes from the presses does not completely remove the "foots," but they continue to settle out for an indefinite period. As the quality of the oil depends to a great extent upon its freedom from these "foots" it is essential that it be stored or tanked for a sufficient time to allow them to be deposited as completely as possible. The quality of some of the special oils, as well as their ease of preparation, are also greatly affected by the amount of "foots" remaining in the original oil.

Linseed oil, on exposure to air, absorbs oxygen with the formation of a neutral substance insoluble in ether called linoxyn. Different statements are made as to the composition of linseed oil and several theories have been put forth regarding the changes which take place. It is generally believed that it is in part composed of the glycerides of linoleic, and oleic acids. Hazura claims to have isolated linolenic and isolinolenic acids. Bedford, on the other hand, assumes that the chief constituents are glycerides of α-linoleic, β-linoleic, α-lenolenic and β-linolenic. It is evident, however, that further researches are required to satisfactorily establish the composition of the fatty acids.

Raw linseed oil, after filtering and storing, while it is the staple product, does not fully meet all the different requirements of the consumer. It is therefore treated and modified in various ways to meet these special requirements and to these oils special trade designations are given. They may be broadly divided into boiled oils and refined, or special oils and among others we would mention:—

Boiled oils: Kettle, ordinary, heavy and extra pale.

Special: Heavy raw oil, varnish oil, refined or bleached oil, and aged oil.

Boiled Oils.—Each of these boiled oils has its special uses, but they are all made by boiling the oil with prepared dryers under very careful control and supervision. The differences in the properties of the resulting oils are caused by variations in the oils used, in the dryers, or in

the methods of boiling and these differences are by no means small, as will be described later. The dryer acts as a sort of catalytic agent in carying oxygen from the air to the oil. Only a very small quantity of dryer is required, in fact an excess of dryer is harmful in that it causes the oil to dry too hard and the resulting film is thereby rendered weak and brittle. Sufficient must be present, however, or otherwise the longer period of boiling which would be required would be equally harmful and produce not only a dark colored oil, but also one of poor quality. Each manufacturer has his own special and carefully preserved methods of making these oils, so that we can only mention their general properties and give such other information as has been made public in the literature.

The principal dryers used are compounds of lead and manganese. The combination of the two makes a better dryer than either material alone. †A bodied oil prepared with lead contracts in oxidizing; one with manganese expands. The most economical properties are stated to be 0.05 per cent. of manganese dioxide and 0.20 per cent. of lead oxide. (P.L.O.) in the boiled oil. When either constituent is used alone the time of drying is increased. It is possible that one of the constituents is more active in absorbing the oxygen from the air, while the other is of particular value in giving it up to the oil. An intermediate transfer of oxygen from lead to manganese, or vice versa, must then occur. Among the dryers used are manganese resinate, mangano-lead resinate, manganese linoleate, mangano-lead linoleate, manganese chloride, manganese borate, lead acetate, lead borate, lead linoleate, lead resinate, manganese sulphate, manganese acetate, manganese oxalate, lead sulphate, zinc sulphate, Prussian blue, Cobalt oxide, etc. In some cases they are used in the dry state, but in this country they are usually in the form of concentrated liquid dryers.

Kettle Boiled Oil.—In the old days all boiled linseed oil was prepared in an open kettle heated by direct heat from a fire built underneath it. This has to be carefully done, not only on account of the danger from fire, but also on account of the possibility of overheating and damaging the quality of the oil. If, properly prepared, however, it is of the highest quality and usually commands a somewhat higher price than ordinary boiled oils. It is usually slightly darker in color chiefly on account of the higher temperature to which it has been raised, and is by far the largest seller, in the province of Ontario especially.

Ordinary Boiled Oil.—This is much the same as the kettle-boiled oil except that it is heated in steam-jacketed tanks or kettles and larger quantities of oil are taken in a batch. The oil also is probably not raised to such a high temperature, although if carefully prepared should be of (good) quality for most purposes. On account of the lower temperature used in its preparation it is lighter in color than the kettle-boiled. A very large percentage of the boiled oil of commerce is made by this process.

In addition to these principal grades of linseed oils there are certain other special oils each of which has its uses. Among these we would mention:—

Heavy Raw Oil.—This is a raw oil treated in such a way as to make it less fluid and with more body to it so that it can hold up a heavy pigment in suspension better than ordinary raw oil. The pigment does not settle so quickly and the paint does not have to be stirred up so much while it is being used. The coat of paint is therefore more uniform in appearance and more pleasing results are obtained. It should dry in a slightly shorter time than ordinary raw oil, but not as quickly as boiled oil. Its principal use so far is in the grinding of heavy pigments by the paint manufacturer, although we do not see why it should not be equally valuable to the painter himself.

Heavy Boiled Oil.—This has much the same qualities as the heavy raw oil, except that it dries more quickly and is used by the paint manufacturer and painter where he requires a boiled oil for heavy pigments and where quick drying is essential.

Extra-Pale Boiled Oil.—This is a light colored boiled oil with specially quick drying properties and is used in the grinding and manufacture of light colored paints and in enamels. A low temperature in boiling as well as special ingredients in the dryers used are the means taken to avoid the darkening of the color.

Varnish Oil.—As its name signifies it is used for the manufacture of varnishes of various kinds. It is not a boiled oil, but is treated in such a way that it will not "break" by any application of heat. When ordinary oil is heated up to a moderately high temperature a flocculent gummy precipitate called the "break" separates out. An oil varnish consists of resins dissolved in linseed oil at high temperatures, the solution being afterwards thinned with a volatile solvent. Owing to the high temperatures used in varnish preparation, the varnish oil must have its breaking property entirely eliminated; but on account of the expensive and elaborate applications of oil varnishes, the oil must retain its durability and elasticity unimpaired by the treatment given to prevent breaking. Each linseed oil manufacturer has his own particular method by which he removes this breaking property, the quality of the product depending partly on the process employed, but largely on the careful attention given to the oil while it is undergoing the treatment.

Refined Oil.—This is an oil which has been bleached and made of a yellowish white color. It is especially useful in the grinding of white paints as it does not injure the color of the pigment. It usually does not "break" on heating, because the breaking element in most cases has been removed. Strictly speaking, however, it is not a varnish oil, although some brands may be used for this purpose if combined with a suitable dryer. Bleached oil, like raw, dries slowly, and it is customary to mix suitable dryers with it. The process of bleaching has to be carefully controlled since if it is carried too far it injures the good qualities of the oil. For this reason a very white oil is not to be recommended.

Aged Oil.—This is a thick heavy oil which has been partially oxidized and the "break" removed. It dries, therefore, somewhat more quickly than ordinary raw oil. Its special use, however, is in the manufacture of patent leather and linoleums, in which industries large quantities of it are used.

The chemical characteristics of these different commercial grades of linseed oil are rather interesting, and we have determined the specific gravities and iodine values of samples of each, most of which have been kindly furnished to us by the Dominion Linseed Oil Company, and made from No. 1 Canada Western flaxseed. The screw-pressed raw oil was supplied by the Sherwin Williams Company:—

†Ennis, loc. cit. p. 239.

Grade of oil.	Specific gravity. at 15.5°C.	Iodine value. (Hanus)
Hot pressed raw oil	.9339	192
Screw pressed raw oil (4½ years old)	.9389	187
Kettle boiled	.9421	182
Ordinary boiled	.9361	184
Heavy raw	.9800	149
Heavy boiled	.9790	140
Extra pale boiled	.9384	183
Varnish	.9350	192
Refined	.9343	190
Aged	.9047	150

The specific gravity of raw oil lies within the limits of about 0.930 and 0.950, depending on the grade and condition of the seed as well as on the temperature employed in cooking the seed. Exposure to the air also increases the gravity by reason of the polymerization and oxidation of the oil. The specific gravity of the boiled and special oils is higher than that of the raw oil as can be seen in the above table, particularly in those which have been partially oxidized, notably the aged, heavy raw and heavy boiled oils. The iodine value as would be expected is lower in a corresponding manner.

In connection with the above we might further mention that we have quite recently been furnished with two samples of oil from the same lot of seed, one of them being obtained without previous cooking of the meal and the other in the regular way. The color of the cold pressed oil is somewhat paler than the other, the taste is quite pleasant with a nutty flavor, while in the hot pressed oil the flavor is somewhat rancid and unpalatable. There is also less foots in the former than the latter, since most of the "mucilage" is retained in the cake. The specific gravity and iodine value of each are not very different, although the former is somewhat lower in gravity and higher in iodine value.

Grade of oil.	Specific gravity. at 15.5°C.	Iodine. value. (Hanus)
Cold pressed oil	.9344	191
Hot pressed oil from same seed	.9352	190

A PORTABLE SUB-STATION FOR A COAL MINE.

The Berwind-White Coal Mining Company, Windbar, Pa., has recently added a 400-k.w. Westinghouse portable sub-station to its equipment and is making a very interesting use of it.

A sub-station consists of apparatus for changing alternating current into direct current, and is generally necessary in mining work, because direct current must be used for haulage in mines, but cannot be transmitted economically over long distances. Hence, when the mine is located some distance away from the power station that serves it electric power can be transmitted more efficiently as alternating current at a high voltage and then transformed to direct current in the sub-station.

The company is developing its outlying properties very rapidly, and need direct current at points where permanent sub-stations are not yet erected. In order to prevent delays in the development the use of a portable sub-station was decided on. This sub-station has the same equipment that a permanent installation has, namely, transformers to step down to a moderate value the high voltage of the current received from the transmission line, a switchboard, and a rotary converter, which receives alternating current and delivers direct current. This apparatus is mounted in a car resembling an ordinary freight car.

When the work at a new development reaches the point where direct current is necessary the portable sub-station is hauled out to the workings, connected to the alternating current transmission system, and is started to work generating direct current. When the permanent sub-station is built the portable one becomes unnecessary and is taken to the next development.

Fig. 1.—Portable Sub-Station, Fully Equipped to Serve Until Permanent Stations are Built.

A further use of this sub-station is to provide insurance against shut-downs. If accidents occur at any of the permanent sub-stations, the portable outfit is sent to carry the load until repairs are completed. One portable sub-station, therefore, is practically the equivalent of a duplicate set of apparatus at each permanent sub-station.

The whole question of the pollution of the Niagara River from Lake Erie to Lake Ontario is involved in the Western New York Water Company's action against the city to prevent this discharge of effluent from the municipal filtration plant into the river. If the city is enjoined from dumping refuse into the stream, then an effort will be made to prevent Buffalo and the Tonawandas from polluting the Niagara. Briefs on the city's motion for a settlement of the issues in the case have been presented to Justice Pound in Buffalo. The private company claims that the effluent from the municipal plant so pollutes the river that it materially increases the cost of filtering water at the company's plant. The city claims that it puts nothing into the river that was not taken from it in the process of filtration, except the chemicals used in purifying the water. The city wants a jury to decide whether the use to which it puts the river is a reasonable one, and whether the effluent emptied into it makes the water any more unfit for domestic use than it otherwise would be. Corporation Counsel Anderson has prepared papers showing that the city of Buffalo is dumping 160,000,000 gallons of raw sewage into the river daily. Tonawanda pollutes the river with 4,500,000 gallons of untreated sewage. The city contends that the discharge into the river of about 300,000 gallons of water, which has been chemically treated, it reasonable when the uses to which other municipalities along the frontier put the river is considered. United States government reports will be used in the case to show the great degree to which the river is polluted by the sewage of up-river municipalities. Government experts are now conducting an exhaustive investigation of the situation, and it is likely that it will result in the discharge of raw sewage into the river being prohibited. The government experts will work out a plan of sewage disposal for Buffalo, the Tonawandas, Niagara Falls and other frontier municipalities that will likely involve the chemical treatment of the sewage before it is dumped into the international stream.

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CONTENTS OF THIS ISSUE.

CANADIAN SOCIETY OF CIVIL ENGINEERS, ANNUAL MEETING.

Notices have been mailed by the Secretary of the Canadian Society of Civil Engineers that the annual meeting of the society will be held at Montreal January 27th, 28th and 29th, 1914. Many of the western members of the society desired to have the meeting held at Victoria, B.C. In a circular letter the Council recently asked the members whether they favored Montreal or Victoria as the place for the meeting. Unfortunately, an idea became prevalent that a vote was being taken. The Council never intended to surrender its privilege of saying where the annual meeting should be held, but merely desired to have an expression of opinion from the members in the matter.

While the "vote" favored Victoria, it was so by reason of the solid returns made from the West, but it was found that very few men east of Sudbury would be willing to go to Victoria this year. It was generally felt that it would be far better to hold a meeting in Victoria in 1915, because that is the year of the Panama Exposition at San Francisco, in conjunction with which there will be an International Engineering Congress. A large number of the eastern members will be willing to go to Victoria for a meeting next year, taking a side-trip to San Francisco.

It is possible that an effort may be made to hold the annual meeting of the society permanently at headquarters in Montreal, just as the annual meeting of the American Society of Civil Engineers is always held at headquarters in New York; but an adjourned meeting, or summer convention, would then be held each year in a different city, until such a convention had been held in every prominent city in Canada.

CRITICIZING A CRITIC.

In a letter to one of the Ottawa daily papers, Mr. Noulan Cauchon, of Ottawa, criticizes the Federal City Planning Commission for choosing Mr. E. H. Bennett, of Chicago, as their planning architect. Toward the end of a letter which occupies a full newspaper column, and which severely "roasts" the Commission for not appointing a Canadian in charge of the work, the following interesting paragraph is noted:—

"Personally, I have spent several years intensively studying, writing and lecturing on the problems of Ottawa and have produced a fairly complete scheme, the only one to date, and which has appealed to scientific and to popular audiences here. I offered to submit the result of these labors to the Commission. Though the offer was gratuitous and several of the commissioners promised to give a hearing they are remiss in having failed to do so, and in having neglected this source of information before deciding on their present course, a questionable one from the viewpoint of fairness at least."

In a postscript to the letter Mr. Cauchon admits his belief that his criticism is "keen" and "stimulating," and assures the Commission that they can count on a continuance of such criticism, as well as on "our continued devotion to the welfare of the plan."

The Commissioners are: Chairman, H. S. Holt, of Montreal; Mr. Frank Darling, of Toronto; Mayor Ellis, of Ottawa; Mayor Dupuis, of Hull; Sir Alexandre Lacoste, of Montreal; and Mr. Home Smith, of Toronto. All of these men, it must be remembered, are giving their

time to the scheme without any remuneration whatsoever. The work is under the direction of Mr. E. H. Bennett, of Chicago, as architect, and Mr. E. L. Cousins, of Toronto, as consulting engineer. A permanent engineer will likely be appointed next spring.

It is very important work, but it is in capable hands. Seven of the eight men who have the work in hand are Canadians. The eighth, Mr. Bennett, was born in England and educated in the finer arts in France. So, when the work is completed, one will truly be able to claim it "a work which in sentiment and in art should be the product of racial and national effort, an expression of ourselves as a nation," which Mr. Cauchon, in his letter to the press, claims to be a most important point.

MANITOBA WATERPOWERS.

Briefly stated, the main sources of dependable power in quantities sufficient for commercial use in the province of Manitoba are the Winnipeg River, the Grand Rapids and the Saskatchewan River, and the large rivers of the north, including the Nelson, the Churchill and the Berens. The power possibilities of the other rivers are limited and of local importance only.

The results of an investigation into the waterpowers of the province are contained in a report which has recently been completed by the waterpower branch, Department of the Interior. The report is now in the hands of Judge Robson, Public Utilities Commissioner of Manitoba, who is engaged in preparing a report for the Provincial Government on the question of waterpower development.

Probably the most interesting feature of the report is the data relating to the Winnipeg River. Its uniformity of flow throughout the various seasons of the year places it among the notable rivers of America. It has a range of 4 to 1 between maximum and minimum, under present natural conditions. Comparing it with the Ottawa River with a range of approximately 40 to 1, and with other rivers noted on page 101 of this issue, the Winnipeg River is shown to be unusually regular in its flow. Further, the flow can be rendered practically uniform by the regulation of the numerous storage lakes on its upper waters. In all it has over 5,500 square miles of lake area. It has a drainage basin of some 23,500 square miles, and its tributary, the English, drains an additional 20,500 square miles.

The report states that 400,000 continuous horsepower are capable of economical development within 80 miles of Winnipeg and within economic transmission distance of all the commercial centres of the province.

These facts obviously disclose an industrial future for the cities of Manitoba. An era of increased activity in manufactures will doubtless culminate in putting the various sources of power into harness.

LETTER TO THE EDITOR.

Fixed Carbon Test Valuable.

Sir,—The writer believes that the fixed carbon test is of considerable value in determining the quality of asphalt cement, and that to eliminate this test would place in open competition certain undesirable asphalts with well-known standard brands. As a result, with the use of these materials, the life of our asphalt pavements would be materially shortened.

It is a well-known fact that the fixed carbon test is one of the quickest and best for differentiating bitumens. It is also an excellent guide in determining the quality of same.

The asphalt containing over fifteen per cent. of fixed carbon would be looked upon with suspicion by the writer if it were to be used for paving purposes. With paraffine hydro-carbons, no fixed carbon is left on ignition, while the amount increases with each decrease in the proportion of hydrogen to carbon. Consequently, the fixed carbon test and the paraffine test are closely related.

If the asphalt produced from paraffine or semi-asphaltic petroleum shows a fixed carbon of over fifteen per cent., it is almost an absolute certainty that the bitumen would not be suitable for paving purposes. With careful manipulation, a pavement might be laid that would give good results for two or three years, but more than this it would not be reasonable to expect.

A high fixed carbon in any asphalt produced artificially shows carelessness in distillation, the material having been coked, burned or cracked whichever you may please to call it.

For example, California asphalts have been placed upon the market showing fifteen to twenty per cent. fixed carbon. These have proven absolutely worthless as paving materials. Other California asphalts showing twelve to fifteen per cent. fixed carbon have given fair results, whereas, as a matter of fact, California asphalt when carefully produced for paving purposes ought to show under twelve per cent. of fixed carbon.

In connection with this statement, it must be remembered that California asphalts are produced from asphaltic oils showing little or no paraffine. The best grades of Trinidad, Bermudez, Cubanel and Gilsonite bitumens show but from eleven to fourteen per cent. of fixed carbon. Grahamite and Albertite, on the other hand, give high fixed carbon results and neither of these materials would be satisfactory for paving purposes.

When it comes to the distillation of Mexican petroleums and the resultant asphalt shows over fifteen per cent. of fixed carbon, the product is to be looked upon with suspicion.

The amount of fixed carbon in a coal measures to a large extent its burning quality. The fixed carbon in an asphalt shows the character of the material in an entirely opposite manner. The higher the percentage of fixed carbon, the less life there is to the asphalt.

Generally speaking, the asphalt produced from petroleum distillation with a high per cent. of fixed carbon, is a hard, brittle product with a high melting point and not suitable for asphalt pavements.

Mexican petroleums, high in paraffine, when carefully produced for asphaltic purposes, ought not to show a high amount of fixed carbon. Nevertheless, numerous of these products do show a high percentage of same.

Very few high carbon Mexican asphalts have been in use for over two or three years and time alone will prove their value.

In regard to the objection that the fixed carbon test is so uncertain, this is more or less true, due to carelessness of operator.

A definite method has been adopted by the American Chemical Society which is as follows: Place one gram of pure bitumen in a platinum crucible weighing from twenty to thirty grams and having a tightly fitting cover. Heat over the full flame of a Bunsen burner for seven

minutes. The crucible should be supported on a platinum triangle with the bottom six to eight cms. above the top of the burner. The flame should be twenty cms. high when burning free and the determination should be made in a place free from draughts. The upper surface of the cover should burn clear, but the under surface should remain covered with carbon. The residue, minus the impurity of ash in the pure bitumen, is the per cent. of the volatile hydro-carbons, excluding the inorganic matter.

This test should be conducted in a hood in duplicate with Bunsen burners protected by a collar. The two tests upon the one sample should be made at the same time. Then, and then only, will concordant results be obtained.

The carbon tetrachloride test which, it is claimed, answers the same purpose as that of fixed carbon, is unreliable. While a high amount of carbenes conclusively proves that an asphalt has been "burned," yet the test is not one that can be absolutely depended upon. In order to be of value, both the carbon tetrachloride and fixed carbon tests are necessary.

In conclusion, I wish to say that simply for the sake of commercializing a few products, it is to be hoped that the highly valuable fixed carbon test will not be eliminated to the detriment of our future asphalt pavements.

HOWARD C. HOTTEL,
Consulting Asphalt Chemist.

Trenton, N.J., Dec. 24, 1913.

CANADIAN PRODUCTION OF IRON FOR FIRST HALF YEAR.

THE American Iron and Steel Association reports that the production of pig iron in Canada in the first six months of 1913, including ferrosilicon and ferrophosphorus, amounted to 545,981 gross tons. The output in the whole of 1912 was 912,878 tons. The production of pig iron in the two halves of 1912 is not available. Of the total in the first six months, 532,431 tons were made with coke and 13,550 tons with charcoal, coke and electricity, etc. The production of basic pig iron in Canada in the first half of 1913 amounted to 292,625 tons, bessemer pig iron to 125,052 tons, and foundry pig iron, ferrosilicon, ferrophosphorus, etc., to 128,304 tons. Forge pig iron was not reported. Of the 545,981 tons of pig iron produced, 345,810 tons were delivered to mixers, openhearth furnaces, etc., in a molten condition, 141,680 tons were sand cast and 58,491 tons were machine cast.

On June 30, 1913, Canada had 20 completed blast furnaces, of which 13 were in blast and seven were idle. Of the total 16 furnaces usually use coke for fuel and four use charcoal. In the first half of 1913 two plants made ferrosilicon and ferrophosphorus in electric furnaces. During the first six months of 1913 the number of furnaces actually in blast during a part or the whole of the period was 15, of which 14 used coke for fuel and one used charcoal. The average number of days the 15 furnaces ran was 167.6, which would give an average make per furnace day of 217 tons.

One entirely new furnace was completed in Canada during the first six months of 1913, No. 7 coke furnace of the Dominion Iron and Steel Co., at Sydney, Cape Breton, Nova Scotia, which was first blown in on May 22. It has an annual capacity of 91,250 tons of basic pig iron.

Two blast furnaces were being built in the Dominion on June 30. One of these furnaces will be operated by the Canadian Furnace Co., Limited, at Port Colborne, Ont. When completed it will be 85 x 19½ ft. and will have an annual capacity of about 125,000 gross tons of bessemer, foundry and malleable pig iron. Lake Superior ore and Connellsville coke will be used. It is almost ready to blow in. The other furnace is being built at Parry Sound, Ont., by the Standard Iron Co., Limited, of Montreal. When completed it will be 60 x 12 ft. and will have an annual capacity of about 36,000 gross tons. Charcoal will be used for fuel. Hematite and magnetite ores from Michigan and Ontario will be used. The Standard Iron Co. also operates a charcoal furnace at Deseronto, in Ontario. The annual capacity of the 20 completed blast furnaces on June 30, 1913, was 1,391,550 gross tons, and of the two building furnaces 161,000 tons, a total of 1,552,550 tons.

SPECIFICATIONS AND METHODS OF TESTS FOR CONCRETE MATERIALS.

THE following is the report on specifications and method of tests for concrete materials of the standing committee of the American Concrete Institute, which, as announced in these columns last July, is the new name of The National Association of Cement Users, as authorized at its last convention. The committee comprises Sanford E. Thompson, chairman, consulting engineer; Cloyd M. Chapman, engineer of tests, Westinghouse, Church, Kerr and Company; William M. Kinney, assistant inspecting engineer, Universal Portland Cement Company; A. N. Talbot, professor of Municipal and Sanitary Engineering, University of Illinois; and G. W. Wise, engineer of tests, Department of Public Works, Philadelphia. Its work during the past year has included:—

(a) Layout of tests of concrete for various laboratories with a view to recommending in a later report standards to be followed in making concrete specimens.

(b) Investigations and compilations of methods of tests of fine aggregate employed by various laboratories.

(c) Studies of results of tests of sand mortars with a view to recommending in a subsequent report uniform methods of test of fine aggregates.

The following report emphasizes the necessity for more rigid requirements for the acceptance of concrete materials and for routine tests of the materials and the concrete. It appeared recently in Vol. 1, No. 1, of the Journal of the Institute.

Tests of Concrete.—Tests of the individual materials are not sufficient for determining the quality of the concrete made from them. A certain sand may give satisfactory results with one brand of cement and prove a failure with another. A sand of a certain granulometric composition may require an entirely different proportioning with one coarse aggregate than with another, or may be unsuited for use with it because of the sizes of the grains.

The committee recommends that for all important structures, such as dams, conduits, and buildings, specimens of concrete be made up in advance of the actual work from materials which it is proposed to use in the work. These specimens should be made under laboratory conditions so as to obtain uniformity in mixing and storage, and with the same consistency which is to be used in the proposed structure. The specimens

should be stored in moist atmosphere and compressive tests made at the age of 28 days and also at other periods if practicable. The final selection of the materials and the proportions to be adopted should be governed by the results of these tests.

The tests now in progress in different laboratories under the auspices of the committee are expected to furnish data from which definite recommendations may be made as to the size and shape of the specimen. The joint committee on concrete and reinforced concrete recommend cylinders 8 inches diameter by 16 inches high. Where it is impracticable to adopt this size, a 6-inch cube or a cylinder 6 inches diameter and 6 inches high is tentatively suggested for use with aggregates under $1\frac{1}{2}$ inches in size. It must be borne in mind that specimens of this shape may give from 10 to 20 per cent. higher strength than the same materials made into oblong cylinders or prisms.

Layout of Concrete Tests.—In order to obtain well-defined information with reference to the effect of different shapes and sizes of specimens and different mixtures, the committee has laid out in very full detail a number of series of tests. These specifications have been sent to various laboratories throughout the country and accepted by them as a part of their routine tests for the coming year. The results of these tests will be presented in the next report of this committee.

Tests of Concrete Materials.—Tests of materials for use in mortar or concrete may be divided into two general classes:—

(1) Tests for acceptance.

(2) Tests for quality.

These two divisions frequently merge into each other because in many cases the special characteristics of a sand may render it unfit for certain work, although it may satisfactorily pass a standard test for acceptance.

The most important questions to be asked in regard to a material are: (a) Can it be used? (b) In what proportions must it be mixed with the other materials to produce the required qualities in mortar or concrete? (c) Can another material of the same class be substituted with greater economy?

For small structures and, in fact, frequently for larger ones where the sources of supply are limited, the all-important question is a combination of the first two, namely, can a certain material—and this applies most frequently to the fine aggregate or sand—be used, and in what proportions to give the desired quality of concrete or mortar? For structures where the volume of the concrete is large so that the economy of the proportioning is paramount, or for small structures subjected to special conditions—such as the effect of sea water—the cement and aggregates should be thoroughly studied also and special tests made to determine the most economical or the qualifications for the work proposed.

Taking the matter of the selection of sand alone, an illustration of the poor quality that is frequently used in practice is found in the tests in the laboratory of one of the members of the committee. Out of 37 samples of sand from different parts of the country made into 1:3 mortar, 12 were equal to or greater in strength than similar mortar of standard Ottawa sand; 5 were between 90 and 100 per cent. of standard sand; 6 were between 80 and 90 per cent.; 4 were between 70 and 80 per cent.; 6 were between 60 and 70 per cent.; 1 between 50 and 60 per cent.; 2 between 40 and 50 per cent.; and 1 between 30 and 40 per cent. Such results as these indicate the absolute necessity for always testing sand that is used in concrete. For large and important structures, such as dams, tunnels, aqueducts, buildings, and other reinforced concrete work, not only preliminary tests should be made, but frequent tests at stated intervals to avoid the danger of inequalities in the supply.

Tests of Materials for Acceptance.—The cement shall meet the requirements of the standard specifications for Portland cement of the American Society for testing materials and adopted by this association. (Standard No. 1).

Fine Aggregate.—Sand or other fine aggregate should always be tested. In ordinary cases where special characteristics are not required, the test for acceptance is the determination of the strength of mortar made up with the cement and fine aggregate to be used on the work in comparison with the strength of identical specimens made with standard sand. The results of this test also are an aid to the selection of the proportions which should be adopted.

Compression tests of mortar are the most reliable, but tensile tests may be employed when a compression machine is not available.

Selection of Sample.—Take an average sample aggregating not less than 20 pounds. Ship in strong box or bag or barrel, preferably water tight, so that laboratory will receive material in its natural condition. Ship in a separate package from the cement.

Quartering.—Unless grains are of uniform size, separate from the large sample the quantity required for the test by quartering or other similar means.

Making Test Pieces.—Mould a large enough quantity so that there will be at least 4 test pieces each to test at 72 hours, 7 days, and 28 days, in proportions 1 part cement to 3 parts sand by dry weight. Bank sand should not be dried, since drying may affect the quality, but the percentage of moisture should be determined by test on another sample, and corrected for in making the weights. The consistency should be the same as that required for standard sand mortar. From 10 to 40 per cent. more water may be required for bank sands or artificial aggregates than for standard Ottawa sand to produce the same consistency.

Similar test pieces of the same cement mixed at the same time under the same conditions should be made with standard Ottawa sand in the same proportions.

All temperatures of mixing and storage should be maintained at 70° F. During the first 24 hours the test pieces should be stored in moist air and the remainder of the period in water.

The 72-hour test is the most severe and sand failing to attain the requirement at this age frequently reaches it at 7 or 28 days and can be accepted. If, however, the 72-hour briquets break in the clips of the machine or if the test pieces at this age show very low strength, say 25 per cent. or below, of the strength of standard sand mortar, the sand should be considered dangerous to use on any important work of construction.

Requirements for Strength.—The aim in concrete construction should be to obtain a sand which produces a 1:3 mortar equal in strength to a similar mortar of standard Ottawa sand. Sands producing mortars having a strength of less than 70 per cent. of standard sand mortar should be rejected.

Between these two limits the variations in strength should be taken into account in fixing the proportions of the mortar or concrete.

Other Tests.—For work requiring special characteristics, the fine aggregate must be accepted not merely on passing the tests for strength, but other tests, such as the test for permeability, the effect of different brands of cement, the effect of frost action and the effect of fire. Characteristics of yield, density, chemical composition, granulometric composition, and amount of organic matter, are frequently required.

Coarse Aggregates.—It is recommended that the quality of the coarse aggregate be determined from the preliminary tests of concrete made with the materials and in the proportions designed to be used in the work. Government tests made at the Structural Materials Laboratory in St. Louis under the direction of Mr. Richard L. Humphrey, clearly show that the hardness of the particles of coarse aggregate appreciably affect the strength of the aggregate, so that greater stresses may be used in concrete when the stone is hard than when it is soft. In certain cases the chemical composition of the coarse aggregate may affect the strength and durability of the concrete.

Tests for Quality of Fine Aggregate.—In addition to the tests for acceptance which have been discussed in the preceding paragraphs, many aggregates require special tests. Furthermore, various laboratories have adopted different classes of tests to use with aggregates which come to them for examination. This can be discussed best by a consideration of the practice in different laboratories.

During the past year this committee has been in communication with all of the laboratories of which they were able to learn, in an effort to gather as complete data as possible relative to the various tests for a sand now in use. Each laboratory was requested to furnish a complete description of their methods of testing sands—in most cases such descriptions were freely furnished. In all, 28 laboratories were communicated with and replies were received from 24; of these, 15 gave more or less complete descriptions of their tests.

The data in these replies were tabulated and listed and gave some very interesting information. It was found that some 26 different steps are taken in these laboratories for the determination of the suitability of a sand for use in concrete or mortar.

Listed and briefly described, these steps are as follows:—

1. **Examination of Deposit** to determine its uniformity, stratification, extent, overburden, methods of stripping, handling, screening, washing, etc.

2. **Preparation of Sample** to eliminate stones, water, silt, and to insure its being representative of the bank or the quantity from which it was taken.

3. **Tensile Test of Mortar** to determine the strength of known mixtures of the sand and Portland cement at various ages and to compare this strength with that of standard Ottawa sand.

4. **Compressive Test of Mortar** to determine the strength of known mixtures of the sand and Portland cement at various ages and to ascertain what mixture is necessary to produce a required strength, or impermeability.

5. **Compressive Test of Concrete** to determine the strength of known mixtures of the sand and a coarse aggregate and Portland cement at various ages and to ascertain what mixture is necessary to produce a required strength or impermeability. In the case of bank gravel or crushed stone which is not to be screened and reproportioned, this test is used instead of No. 4 above.

6. **Percentage of Moisture** is determined in order to allow for the water contained in the sand in proportioning mixtures, computing freight rates, etc.

7. **Percentage of Voids** is determined:

(a) By determining the specific gravity of the solid particles and weighing a known volume of the sand and computing therefrom the percentage of voids.

(b) By filling the voids in a known volume of sand with a measured amount of a liquid.*

8. **Yield, or Volume of Mixtures** is determined by adding a known quantity of cement to a known quantity of the sand, wetting the mixture and noting the increase in the volume of the sand. This is repeated with various proportions of cement and sand to ascertain the amount of cement required to fill the voids in the sand.

9. **Density of Mortar and Concrete** is determined for various mixtures of cement and sand and of cement, sand and stone to ascertain that mixture which gives a material of the greatest weight per unit of volume.

10. **Specific Gravity of Solid Particles** is determined by three different methods:

(a) By the specific gravity apparatus such as the Jackson flask.

(b) By pouring a known weight of sand into a known volume of water and noting increase of volume of liquid.

(c) For coarse aggregate by suspending pieces by a thread on chemical scales and noting weight in air and weight when hanging in a jar of water.

11. **Specific Gravity of Sand,** including voids, is determined by weighing a known volume of the sand exclusive of moisture and computing the specific gravity from the known weight of the same volume of water. Having determined the specific gravity of the solid particles (Test 10) and also that the sand (including voids) the per cent. of voids in the sand may be calculated.

12. **Weight per Cubic Foot** is determined by weighing a known volume of the sand. This test is very closely related to Test 11.

13. **Granulometric Analysis or Mechanical Analysis** is made by passing a known weight of the sand through a series of sieves of various sizes and noting the amount retained on each sieve and the amount passing the finest one. This test shows the distribution of the particles from fine to coarse.

14. **Uniformity Coefficient** is determined from a curve plotted from the granulometric analysis by dividing the diameter of the particles at the point where the curve crosses the 60 per cent. ordinate by the diameter of the particles at the point where the curve crosses the 10 per cent. ordinate.

15. **Wet Screening** of a sand on the 100 and 200 mesh sieves shows the amount of fine material which can be washed from the sand and which in the case of dry screening in Test 13 often adheres to the larger particles and so leads to uncertain results.

16. **Silt Suspended in Water** is determined by agitating a quantity of the sand with a large excess of water in a tall cylindrical glass vessel and noting the amount of silt which becomes suspended on the water and later settles down on the top of the sand.

17. **Silt Washed Out** is found by agitating a known quantity of the sand in water, allowing the coarse par-

ticles to settle and decanting or syphoning off the muddy water from the top. This operation is repeated until clear water is obtained. The amount of silt washed out is determined after evaporating the water.

18. **Loss on Ignition** is determined by heating to a red heat a weighed quantity of the dried sand and again weighing after cooling. This test is best performed only on the silt washed from a quantity of sand, as the silt usually contains the injurious organic constituents of the sand.

19. **Organic Matter** is sometimes determined after the methods employed by the agricultural chemists.

20. **Chemical Analysis** is made to determine the character of the sand grains. Only a few of the most common rock constituents are usually determined quantitatively, for the purpose of judging of the strength and durability of concrete made from the sand. A high silica content is usually desired.

21. **Microscopical Examination** is made to ascertain the approximate size of the grains, their shape, character of surface and to detect the presence of objectionable material or foreign matter such as mica or small roots or a coating on the grains.

22. **Absorption of Mortar and Concrete** made from the sand mixed in varying proportions with cement or cement and stone is determined to ascertain its suitability and the proper proportions for the production of a product having a minimum of absorption.

23. **Permeability of Mortar and Concrete** made from the sand is sometimes determined for various proportions of the constituents in order to determine mixtures for the production of an impermeable mortar or concrete.

24. **Effect of Different Cements** on some sands is quite variable and tests are sometimes made to determine with which of several available cements the sand will give best results.

25. **Freezing** during the setting time has a more injurious effect on mortar and concrete made with some sands than those made by others, and tests are made to determine the extent to which the sand is affected by freezing.

26. **Fire** has a more disastrous effect on some sands when used in mortar or concrete than it has upon others and a heat test is made to show the ability of the sand to resist fire. No two of the many laboratories engaged in this work have used the same tests, and scarcely two of them carry out their tests in exactly the same manner, so that at present it is difficult or impossible to accurately compare the results obtained in one laboratory with those obtained in another.

Examination of the list shows that the popular tests for sand at the present time are granulometric analysis, tensile tests of mortar, and percentage of voids. Of these only one, the tensile test of mortar, belongs properly in the classification of tests for acceptance as discussed in preceding paragraphs of the report.

The problem before the engineer who is interested in proper methods of testing materials is to select and standardize such tests as will give the necessary data which will determine whether or not the sand is suitable for a particular use and, if suitable, in what proportions it should be used to produce desired qualities in the resulting mortar or concrete.

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*This method as usually practised is very inexact on account of the air entrained.

WOOD PIPE LINE CONSTRUCTION IN THE WEST

The question of water supply is one of the most difficult problems with which the western railroads have to contend. Each year large sums of money have been expended—and not always successfully—in an effort to obtain a good supply. In the prairie sections water is sometimes very scarce and has to be piped many miles from the source of supply to the point where it is to be used; and in many cases the water is unfit for boiler use in the raw state and has to be treated by some softening process. Even after a seemingly good supply has been located it is hard to judge as to whether it will be capable of producing enough water for the purposes required. There are a few plants (generally of the well type) which have turned out decided failures, having been pumped dry in a short time. This state of uncertainty will, of course, disappear when we have more extensive data on the streams in the west—such as the hydrographic survey is preparing from observations of its engineers. As it is now, the water supply engineer has to make many assumptions and therefore one should not judge him too harshly if he makes an error.

The engineering department of the Canadian Pacific Railway Company has been making observations and collecting data respecting certain possible water supplies with a view to their usefulness at a future date, when new lines and heavier traffic will demand more water. One of these points is Rock Lake, which is situated nine miles northwest of Stoughton, the junction of the Regina and Weyburn subdivisions. Water was required here on account of the heavy freight traffic which is being diverted from the main line. Heretofore the tank at Stoughton had been filled with water from Kisbey, a station eight miles south of Stoughton, necessitating the hauling of water cars every day, and making it a very expensive supply. The water of Rock Lake is quite suitable in the raw state for boiler purposes.

Rock Lake is a body of water with an area of 360 acres. It is situated at the junction point of several coulees amid rolling land, and has no surface outlet or inlet, the water being gathered entirely from underground springs and from surface drainage in the wet season. The shore and bottom of the lake are of quartz sand and boulders. The country roundabout is clay loam on the surface, while in the immediate vicinity of the lake one runs into quicksand 6 feet from the surface, which changes to a mixture of sand and clay toward the higher land.

The pipe line was located along a road allowance from the lake to the railway track, and was then turned into the right-of-way where it paralleled the centre line direct to the tank, totalling 6½ miles on the road allowance and 2½ miles on the right-of-way.

The plant at the lake consists of pumphouse and cottage for pumpman, both being frame buildings on concrete foundations. A well 16 feet deep and 16 feet in diameter was sunk and connected to the lake by an 8-inch iron pipe 190 feet long, the water flowing in by gravity. The water is pumped from the well through an 8-inch cast iron suction pipe to the pump, and discharged into an 8-inch wooden pipe, wire-wrapped, pitch coated, and tested for 350 feet of head pressure. The wooden pipe line was laid in an 8-foot ditch for protection from frost. In short potholes and places where it was impossible to get a good joint by following the ground line, the pipe was put down as far as possible and extra material placed on top after backfilling was completed. Air valves were

located on all summits, there being 9 of them on the entire line. There are 4 gate valves at approximately uniform distances, but located in sags wherever possible. There is also a gate valve in the cast iron pipe on the intake side.

The buildings, intake works, manholes, etc., for the line were built by the bridge and building department of the Canadian Pacific Railway, under the superintendence of Geo. Armstrong, bridge and building master. The contract for ditching, laying and backfilling was awarded to the J. A. Broley Co., of Fernie, B.C. The contractor started work on the ditch close to Rock Lake and worked toward town. Harvesters' cabooses, drawn by horses, were used as cook and sleeping quarters. An Austin drainage excavator fitted with caterpillars was used for ditching. At the start it was not very successful, owing to the presence of quicksand, which filled in before the pipe could be placed. As a result it was decided to leave all bad places to be finished by hand. When the machine reached higher ground it made better progress, although a great many delays were caused by the bucket chains breaking by being wedged against stones, which were quite numerous in places. As the pipe was so easily laid in the dry places it was often put in during overtime after supper, the men working on the wet spots during the regular day. When the machine was digging in sandy soil which was not too closely packed it could make 800 feet a day, but sometimes breakdowns to machinery from the above unavoidable causes would reduce this to one-half the amount.

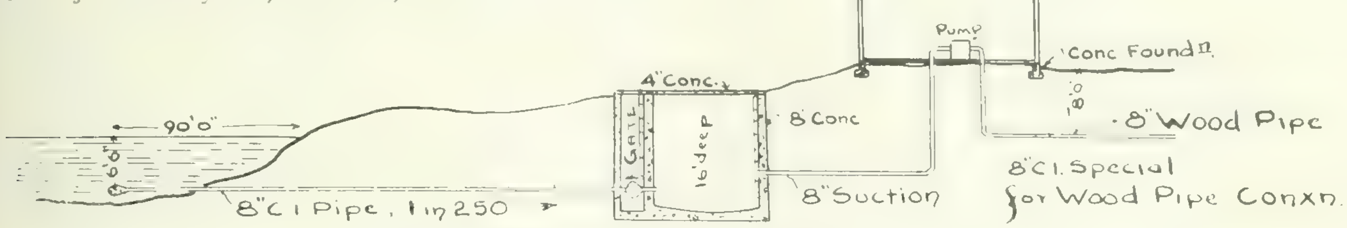

Fig. 1.—Section Showing General Arrangement of Plant and Piping.


Fig. 2.—Rock Lake and C.P.R. Pumping Plant.

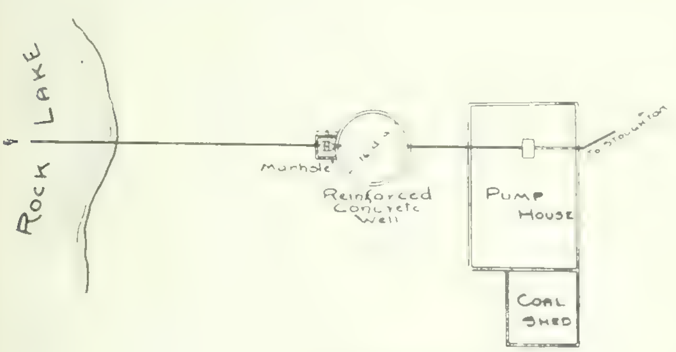

Fig. 3.—Plan of Intake and Pumping Plant, Rock Lake.

The pipe was prepared for driving by filing the spigot end so as to allow the pipe to enter the sleeve easily. This filing also prevented the end of the pipe from splintering, and the fibres from turning back and causing leaks. After filing, a little gear grease was applied to the spigot to aid in driving; the sleeve end of the pipe was also carefully inspected to see that no lumps of pitch adhered to the wood, as this is also a possible source of leakage.

The longest stretch of pipe laid in one day was 1,629 feet. The number of men actually engaged in driving was as follows: 1 foreman; 1 man filing and greasing spigots of pipe (part of time and tamping part of time); 2 men on surface dropping in pipe (sometimes having to carry pipe for short distances); and 3 men in the ditch driving pipe and removing material left by machine. The men in the ditch also attended to the tamping when held up for pipe or other reasons.

The pipe was driven by a dolly made of a tamarac tie about 5 feet long and ironed on each end to prevent brooming. It was suspended from a chain attached to a plank across the ditch. The pipe was protected by a plug of fir inserted in the sleeve while driving.


Fig. 4.—Pipe Line Construction Through Water Covered Land.

The wet places were dug by hand, sheet piling being used to hold the bank up. Several methods were used by different foremen, but the best results were obtained by digging holes from 8 to 12 feet long according to the conditions, leaving a space of 2 or 3 feet between. This space was afterwards tunnelled out. By this method less sheet piling was required and as the pipe was laid, the water was dammed in the tunnel reducing pumping to a great extent; generally an ordinary diaphragm pump being all that was necessary—although larger pumps had to be used in several cases.

Where sloughs with water on the surface were encountered the method of procedure was to build a puddle dam about 6 feet on each side of the centre line, and then to pump out the space between, by gasoline pumps. In

one case a 6-inch centrifugal pump was necessary as the quantity of water was too great to be removed by slower methods. After the water was removed from the surface, the method of excavation above described was feasible.

Some difficulty was experienced during wet weather on account of the pipe being raised by the buoyant force of the water, which filled the ditch in low-lying parts. In some cases the pipe dropped to place on the removal of the water, but where sand had worked in under the pipe, it was necessary to remove the pipe, and clean out the ditch, afterwards relaying the pipe. This trouble, however, would not have occurred if the backfilling had been done regularly, and kept close to the pipe-laying, the work being in the hands of a subcontractor. A mormon scraper was used for backfilling the ditch, one team and 2 men being able to do 700 feet of dry work or 200 to 300 feet of wet backfill in a day.

WATER IN MACADAM ROAD CONSTRUCTION.

An interesting and instructive paper on the subject of the part played by water in macadam road construction was read on November 24th, 1913, by W. G. Fearnsides, M.A., F.G.S., fellow of Sidney Sussex College, Cambridge, and Sorby professor of geology in the University of Sheffield, before the British Surveyors' Institution. Professor Fearnsides endeavored to show that though the chemical action of water upon materials in roads is small compared with the rate of mechanical wear, yet water in excess is most generally responsible for the automatic disintegration and decay of roads, and also care should be exercised in the choice of materials to be buried in road foundations so as to use those less rapidly affected by the solvent action of water. The lecturer also dwelt upon the fact that the power of water to bind is an effect of surface tension; and for maximum strength and efficiency it is important that the proportion of water be kept at the optimum; "as dry as it can be drained" being the first approximation to the optimum for most water-bound road materials. He did not deal further with the subject, but concentrated his remarks upon water as a disintegrator and as a binder, and more particularly in the road crust; though a small part of his paper, he devoted to a consideration of the ground formations on which roads are built. It has been shown that in some instances the lecturer has shown the disadvantages without noting the advantages of the various effects which water has upon materials discussed; i.e., the effect of water in dissolving the felspar of certain stones; the effect of water on rocks containing iron in the ferrous state; the effect of water on limestone road crusts; and the effect of chemical action upon the foundation course or bottoming of the road. However, the paper has been described as one which "gives the road-making world plenty of food for thought," and his conclusion that for each and every road aggregate there is a characteristic optimum proportion of water, which, if he is to produce the most efficient service for the road user, the roadmaker cannot afford to disregard.

The gist of Professor Fearnsides' paper is given in the following detailed account:—

Geologists and makers of roads have long found common interests in the study of stones, both as road metal and in the bed rock on which the roads are built. The speaker wished to direct attention to the special part played by water as an essential constituent of all road constructions, and as the agent which, present in excess, is most generally responsible for their automatic disintegration and decay.

Water, strangely useful and commonplace in many of its properties, is in others strangely unusual and peculiar, and after all these years of progress remains in many essentials an enigma to the scientist. To the chemist the most striking property of water is its power to dissolve a little of almost everything, and that with many substances it combines to form hydrates. To the physicist perhaps the most remarkable properties are the high boiling point, the vast change of density when water evaporates, and, related to this, the great skin strength of surface energy possessed by liquid water. Other important properties are the high values of the latent heat constants both between ice and water and for water which is evaporated. The circumstance that water expands by one-eleventh of its volume when it becomes ice is almost unique, and, coupled with the other circumstance that the solidification temperature of water lies within the normal range of diurnal or seasonal variations of atmospheric temperature, leads to those phenomena which collectively we describe as frost.

Considering these properties of water from the point of view of the water in roads, water left to itself will, in time, dissolve a little of almost any road material. Natural waters have at one time fallen as rain, and in their passage through the atmosphere have taken up carbonic acid and oxygen from the air. Water as a solvent cleans the surfaces of the mineral particles which aggregated form the road stones, and brings the carbonated and oxygenated water into chemical contact with the bare surface. If all the mineral particles of the stones are of such composition that none of them react with the aerated waters, all is well, and neither rain nor water carts can work chemical damage to the road. Usually this is not the case, and, except in the case of flints, and perhaps some quartzites, there is reaction between atmospheric waters and some or other of the mineral constituents of the road stone, which in time leads to the disintegration of the stone.

Any rock which contains felspar—and the best road stones, granites, syenites, diorites, basalts and the like consist largely of felspar—will have the felspar gradually attacked, and the less silicious the felspar the more soluble does it prove. Any rock which contains a mineral rich in iron in the unoxidised—that is, in the ferrous—state will have that mineral rusted as well as partially dissolved. Any rock which has a mineral rich in lime will have that lime mineral transformed to calcium carbonate, which, in continuation of the same process, will surely be dissolved. Any sulphide mineral will in time be in part oxidized to sulphate with the production of some free sulphuric acid, a substance which may be trusted to disturb the equilibrium of its surroundings, and greatly to further the disintegrating process.

Chemical Disintegration.

The rate at which stones in a road crust suffer chemical disintegration is not, in general, great as compared with the rate of mechanical abrasion by traffic; but in the under or foundation layer, where "out of sight is out of mind," and the stones are left to stew in water—sometimes percolating, sometimes stagnant—for whole seasons together, chemical solution is the process which counts. On ordinary road stones solvent action is most destructive and rapid when it attacks carbonate of lime present as a cement holding other

and less soluble mineral grains together. The hard cement stones of the lias and the oolite clay districts of the south-eastern Midlands often go to pieces from this cause. Corallian calcareous grits of Yorkshire and Dorset, upper and lower greensand of Devonshire and the Weald, and even the famous Kentish rag in its less compact condition, should be protected from the solvent action of water, and when buried are never free from suspicion. Bastard limestones, much used for second-class roads in the Pennine district, as well as in parts of Devonshire, Shropshire and North Wales, also suffer solution changes, but with the increase in the percentage of lime carbonate the dissolving waters become saturated at the surface of the stones, and the danger of actual disintegration by partial solution is reduced.

Igneous rocks, when compact and fresh, are attacked so slowly that through the space of one man's life they may be considered as immune. If already porous and partly weathered in the quarry they generally contain some carbonate of lime, and may quickly go to pieces when subjected to continuous soaking within the road. In certain regions, such as the English Lake District, the Breidden District, the mountain district of North Wales (including a certain section—now proverbial—of the Holyhead road), it often happens that this type of altered igneous rock is the only rock which the casual laborer has skill enough to quarry, and though excellent material is available at no great distance, these, and these only, are used upon the roads.

Of all road materials now in common use, those that are most rapidly affected by the solvent action of water are the slags. Slags upon a road crust can be observed, and though after every shower the characteristic aroma of their reaction with water can be smelt, it is a matter for argument whether their cheapness does not compensate for the rapidity with which they disintegrate, whether under the action of atmospheric water or under traffic. Placed beneath the crust to act as a go-between and weight distributor from the road surface to the foundations, no slag is ever safe, and numerous are the cases known to me where estate roads made up with slags and dressed with satisfactory coatings of the best macadam developed crop after crop of potholes by reason of the spasmodic and irregular, sudden or gradual disintegration of odd pieces of the slag which lie invisible and soaking continuously in the ground waters below.

Physical Characteristics of Water in a Road.

The speaker considered first the property by which water wets the solids with which it comes in contact. The primitive concept of a liquid as a fluid which wets things is widespread. Certainly the liquid water does wet—that is, spreads as a film over the surface of most common solids—but it is not difficult to mention a score of liquids which, when sprinkled upon the surface of common solids, refuse to wet them, and which, instead, curl up into globules and remain as scattered drops upon the surface. This difference of behaviour is due to intrinsic differences between two classes of liquids, and the physical property which controls it can be numerically evaluated and tabulated, and is known under the name of "surface energy" or "surface tension."

For a liquid to wet a solid there must be a degradation of energy when the two surface films (solid-liquid and liquid-air) are substituted for the one surface film (solid-air). When, on the other hand, a liquid refuses to wet a solid, there is indication that the energy value of the solid-liquid plus liquid-air surfaces would be greater than the energy value of the existing single surface film of solid air.

Glass is a solid readily wetted by water. When two glass plates are brought close together with one or more drops of water between, the two plates stick together, and the force required to drag them apart is considerable. Professor Fearnsides did not attempt the mathematical analysis of the manner in which the force which resists the parting of the plates is developed—it is discussed in Poynting and Thomson's "Properties of Matter"—but merely said that it was determined by (1) the surface tension—i.e., the skin strength of the water; (2) the curved water-air surface, which, by reason of its surface tension, the water in the narrow space between the plates develops, and (3) the difference of pressure inside and outside the water film which the curved skin of the water renders possible and necessary. The net result is that two glass plates with a water film between require a force almost equal to the pressure of the atmosphere (about 15 lbs. to the square inch) to begin to separate them.

This experiment may be repeated using plates of mica instead of glass, and find that the force required to drag apart the wet mica plates is slightly greater than in the case of glass. A whole series of damp mica plates may be piled together and it will be found that in order to break the column of the mica pile force almost as great must be employed. In order to obtain the maximum tensile strength of piled plates it is essential that the plates should be flat-sided and in parallel position. Plates with water drops between, and kept from parallelism by a match stalk wedged in at one edge, are not difficult to separate. To separate curved surfaces of glass with water drops between requires some expenditure of energy, but the plates come apart quite easily.

Behaviour of Water-bound Materials.

The experiments just indicated exactly reproduce the behaviour of water-bound materials in a road. The road materials which, bound with water, are most strong, are those which break into pieces with flat faces, and whose constituent minerals break with a cleavage into flat-faced grains, and are readily wetted by water. Derbyshire limestone, for instance, breaks into flat-sided tetrahedral pieces which will pack, and its powder consists of the flat-faced rhombohedra of calcite. With the right amount of water Derbyshire limestone binds magnificently.

Our experiment was made with mica. Sorby, Hutchins and others have proved that most clays consist of minute flakes of mica. Clay makes excellent bricks, which, when dried, are strong enough to stand one upon another to the full height of the kilns even before they are burnt. This strength is the strength of the water films between neighboring mica plates, strength exactly analogous to the strength of water-bound macadam.

If the experimental pile of mica plates, or the brick dried ready for the kiln, be dropped into water, the air which with water shares the narrow places between the mica flakes is displaced, and the strength of the aggregate so diminished that the mica pile becomes "weak as water," and the brick "falls" to muddy clay like, but more muddy than, the clay from which it was made.

Tensile and Crushing Strength.

The professor mentioned this behaviour of bricks to suggest that, by making briquettes of crushed road

stone, an excellent indication of the binding power of the road stone can be quickly obtained.

The speaker said that he had tested the strength of briquettes made from road stones which have been collected at various places, and had found that in general those rocks which have the lowest silica percentage when briquetted give the greatest tensile and crushing strength. With certain rocks, such as flint, he had failed to make briquettes except with the addition of a quantity of clay binder, and had found that when powdered flint is added to clay the strength of the briquette is that of the clay only. He had made briquettes from fresh road stone (Clee Hill dolerite) freshly powdered by himself, and from road scrapings taken from a water-bound road of Clee Hill stone which was well-nigh worn out, and had found that the strength of the briquette of the road scrapings is less than one-quarter that of the freshly crushed rock. He had also tried to make briquettes of road sweepings from a tar-bound road of Clee Hill stone, and was rather astonished to find that these sweepings failed to bind. Now he recognizes that spent tar and pitch belong to the class of solids which water does not wet, and from the similarity of the behaviour of powdered flint groups raw flint with these as the one common rock which water does not wet, and which, therefore, it cannot bind.

Thus far has been considered the strength of a water-bound aggregate as an absolute property which is determined by the form and composition of the particles bound. As a matter of fact, with one and the same aggregate of rock fragments mingled with different proportions of water, the strength (that is, the stress which the aggregate can accept without coming asunder) varies enormously. It is recognized that stone dust when dry has no strength, and that when fully wetter to the state of mud its strength similarly is nil. In the intermediate damp stages the strength is considerable and characteristic. This may be conveniently expressed in the form of a curve, which passes through the origin, rises very rapidly to a definite maximum, and then falls away again.

The most important characteristics of the curve are (1) the height of the maximum (i.e., the maximum strength); (2) the distance from the origin (i.e., the percentage of water) at which the maximum occurs. Powdered mica gives a high maximum very close to the origin; powdered quartz a low maximum rather far away. This curve should be determined experimentally for each road stone used in large quantity. Professor Fearnsides inferred that rocks whose strength attains a maximum with little water are suitable for use in dry climates, while those in which the maximum is far from the origin are more suited to the damp atmosphere and frequent showers of the hills; and he believed that experience on the road confirms this inference. Quartzite and flint roads are undoubtedly at their best after rain or in damp weather, at which times water-bound limestone roads become almost impassable.

The lecturer said that he had labored these details of the origin of the strength of water-bound aggregates at some length, because, both from observation and from experiment, he concludes that it is the statical strength of the road crust that determines its resistance to wear. If the passing loads distribute stresses which can be taken up by elastic deformation, there is no grinding of stone on stone within the road crust, and the work done in deformation is dissipated without altering the conformation of the road aggregate. At their best most roads are strong enough thus to carry their loads without serious internal wear, but who, in wet weather, or after a frost, has not heard the "scrunch, scrunch" of internal grinding of the stones beneath the wheels of a wagon as it passes along a road? The importance therefore of maintaining the quantity of water in a road at a proportion not far different from that required for the condition of maximum strength is considerable. To this proportion the speaker hereafter refers as the "optimum."

Potholes.

The subject of potholes is closely related. Potholes are areas where, by faulty or non-homogeneous construction of the sub-crust, or by some other cause, the road crust is maintained or remains damp for periods longer than in the areas adjoining. Hence when, after a wetting, the average of the road in drying passes from a condition of weakness to a condition of comparative strength, the place of the pothole remains weak, and the passing traffic continues to grind stone upon stone within the crust at times when over the rest of the road this type of wear has ceased.

Two years ago the professor said he came across an old road-mender on the Cambridge-London main road at his wits' end to cure a crop of potholes in front of the entrance to a patron's estate. The subsoil at the place is coarse gravel, and the road has been mended several times without remaking. It seemed, therefore, that this was a case of water standing in puddles in the sub-crust. He therefore persuaded the old man to drive a bar or spike down to the gravel in the midst of each of his potholes, and passing the place this summer rejoiced to be informed, and to see for himself, that, though the strip of road has not yet been redressed, the potholes are no more.

Allowing that explanation of potholes is correct, it follows that a uniform and complete sub-crust drainage will entirely prevent them, and that there can be no cure for existing potholes as long as water in the sub-crust distributes itself irregularly. It also follows that there can be no surer method of securing the development of potholes than to put upon a wornout and insufficiently scarified road a thin dressing of new macadam. Road surfaces, by the crushing of the surface stones, become fairly impervious, and each depression or rut which is covered by the new coating is a cup to hold water longer than does the rest of the road, and hence the over-rapid wear of the road crust above it is assured. The distribution of sub-crust water-pockets and their resulting potholes is a long and complex subject, and with the comment that over-watering in the dusty season is one of the most effective methods of keeping the water-pockets supplied with water, the speaker proceeded to other matters.

"Site-Rocks."

Not only does water give strength to macadam, but it is water which holds together the particles of which the weaker of the road "site-rocks" (or ground foundations on which the roads are built) consist.

Site-rocks from the point of view of the road-maker may be divided into three classes:—

(1) Rocks which consist of compact pieces of hard material separated one from another by joints or open spaces which are wide enough to allow water to pass freely through them under gravity. These give no trouble to the road maker, and beyond the clearing away of irregularities and the removal of soil, the sites which they afford require no preparations for the road crust coating.

(2) Rocks without open joints, in which the constituent mineral particles are fairly large and the pores between them wide enough for water to filter slowly through. Road sites on these foundations are sufficiently well protected from the accumulation of excess of water by the provision of adequate lateral drains.

(3) Rocks fine-grained and argillaceous. These, the clay rocks, consist in large part of minute flakes of mica, and owe such strength as they possess to the air-water films which bind them. These have mostly originated as mud upon the sea bottom, but as found in mines and deep cuttings, by reason of the pressure of overlying strata, they have lost much of their water and become strong. Exposed to the atmosphere for long periods, in the soil, or kept in contact with water, they "fall" to slime or incoherent mud, and while they are "falling" they develop the properties of a viscous fluid. Kept dry they retain their strength, and some of them if laid bare in dry weather may increase in strength. By reason of the fineness of their grain they are well-nigh impervious to the percolation of water, and any water which comes upon them either is absorbed to the diminution of the strength of the clay it wets, or, diverted by the impervious surface, flows away under gravity. Though the process of absorption is more or less slow, it is continuous and sure, and whenever a load is borne upon a surface of clay which is kept constantly wetted there must eventually come a collapse.

Landslips generally occur on hillsides where a clay foundation supports more massive rock, and, becoming wetted by trickling water, can withstand their load no longer. Road sites of argillaceous rock must therefore be guarded with special care from the action of water. Lateral drains are the best preventive against the water from outside, but the American method of shaping clay road sites with a plough and compacting them to a camber with a steam roller before making up the road at all, is one which commends itself to the geologist as a means of conducting away the water which enters from above. Upon the cambered clay surface sufficient of a coarse-textured make-up layer must be provided to distribute the pressure of traffic over a wide base, and to act as an open drain to the water which sipes in through the road-crust.

Many of the worst roads are along outcrops where pervious and impervious rocks meet, and it would be well if those whose profession it is to plan new roads could avoid such localities. Springs occur at these places, some of them with continuous flow, others rising intermittently as bournes only when the level of ground water in the porous strata comes to the surface; and if here the road be founded upon a clay rock which loses its strength by wetting, trouble must ensue. In any case the access of ground water to the road crust cannot do other than impair the wearing power of the road.

Variation in the Properties of Water.

The lecturer noted first the changes of vapour pressure. By reason of the changes in the maximum pressure which water vapour can sustain, there is the phenomena of dew and hoar-frost, and, for the matter of that, all the phenomena which accompany and control the humidity of the atmosphere and the precipitation of rain. These, and the influence they exert on the production and laying of surface dust, so force themselves on the notice of road makers that they are always watched for, and as far as possible kept in check by the surveyor's arrangements for the disposal of excess, and for the supplementing of any deficiency of water.

Before leaving this subject he drew attention to the influence which the surface form of the water has upon the temperature of saturation. This influence has been well studied in the case of rain-drops, but seems to have passed unnoticed in the case of the water surfaces among the crannies of stones, where films of water are giving strength to clay or binding macadam together. The dew-point for convex surfaces is lower than that for flat ones, and, again, the dew-point for concave surfaces is correspondingly high, rising the more in proportion as the curvature (that is, the narrowness of the cranny) is increased. Who has not noticed that the large pebbles on a beach dry more quickly than does the sand? Who does not know that a sandy soil remains damp less long than a field of clay? It is all a matter of curvature of the water surfaces. For the same reason a new-coated road, in which all the surface particles are still large, remains unaffected by dew or incipient fog long after an old and well-trafficked road has been reduced to a condition ideal for a skid.

Flint, as has been already seen, behaves as a material which water does not wet, and between flint fragments the water stands in globules. Flint roads, therefore, do not become slimy under the action of dew, and, despite its excellence as a "puncture mixture," there is no more efficient material than flint grit for sprinkling on wet and dirty roads to reduce the slipperiness.

Sub-Crust Dew.

There remains also the important question of sub-crust dew, which "droppeth" not "as the gentle rain from heaven," but rises or transpires from "the waters under the earth" whenever the outside atmospheric temperature falls below that of the rocks within. Like normal dew, when it arrives at the cooled surface, it precipitates itself upon the water films, and, increasing the proportion of the water beyond the optimum, reduces and perhaps altogether destroys the strength of the road crust. Each autumn we see water-bound roads which have been strong all the summer going to pieces from this cause; they seem as if they will never dry. Roads dry and good before a frost are notably wet and unpleasant when the thaw comes, and this whether or not rain has fallen in the interval. Tar-painted and other roads with waterproofed surfaces are just as bad as unpainted ones with respect to this, and, indeed, the over-wetting of well-drained water-bound roads after a frost is only rendered possible by the sealing of the outward ends of the air passage by ice, a sealing which by design is already accomplished in the process of waterproof painting. As to means of preventing the ravages of sub-crust dew, Professor Fearnsides had nothing to suggest; but said that just in proportion as the source of the warm underground water is easy or difficult of access, so is the process of surface condensation immediate or delayed.

Efficient sub-crust drainage is therefore important, not only for keeping up the general strength of the road crust, but also because it delays the arrival of the winter's damp, and so secures that the proportion of days when the road's optimum strength is reduced is kept as low as possible.

The Phenomena of Frost.

Frost swells the water which is contained in narrow places, and whether the narrow places are cracks within the stones or crannies in which the water is at work binding the stones together the water must expand,

and the cracks must open. In well-drained roads in which the water content does not far exceed the optimum, there is generally ample room for the ice to expand between the stones. Where, however, by the choking of the sub-crust drainage, or by continued condensation of sub-crust dew, the air spaces in the road are more completely filled with water, the frozen crust has to expand, and expanding detaches itself from the rest of the road, and rises as the cavernous blisters which we know so well. Then comes the thaw, and the bursting, disintegrating and disarranging work done by frost becomes evident; but much of the winter damage ascribed to frost is really the work of sub-crust dew, and can be minimized by the provision of a proper porous make-up layer in which water does not accumulate.

The discovery of Macadam was that road stones so broken that they would pack are held together by films of water. Makers of modern roads follow Macadam in preparing road metal aggregates by breaking stones to a more or less uniform mesh, but with the coming of motor traffic and its attendant dust they have had to find binders stronger than water, in order to hold their stones together under the increased stress of traffic. Except for raw flint, the road materials known to Macadam were all substances which water wets with avidity, but in these modern days this is altered, and materials which water cannot bind have now to be reckoned with upon our roads.

When carbonaceous binders are new laid they are viscous and resilient, and yield under stress without breaking; but when, with lapse of time, by differential evaporation of the tempering oil they become hard, they break under the hoof or wheel, and make a mud, or rather an emulsion, which is devoid of strength. When looked at with a lens, spent tar or pitch which has been scraped from a wet road and laid on blotting paper, shows the water curled up as globules between the pitchy splinters, and without raising the temperature all my attempts to make it into briquettes have resulted in failure. Water will not bind it, and if a proportion of it be mingled with powdered road stone the strength of the water-bound mixture is diminished as the proportion of the powdered pitch increases. Users of cars have learned to respect the iniquities of the churned-up mud which in certain places accumulates on tar-painted or pitch-bound roads. Mud rich in animal or vegetable refuse has similar characters.

There is also another side to this question, and this involves the success or otherwise of these carbonaceous binders. Water does not wet the binder, but water does wet the stones, and if water has spread itself as a film over the surface of the stone the carbonaceous binder cannot "wet" the water, and therefore cannot get into contact with the stone. Even if by drying the water has been removed from the stone surface, it is likely to remain in the narrow cracks and capillaries, and when the carbonaceous binder spreads over and adheres to the general surface, it fails to make contact with the damper spots, and its hold upon the stone is incomplete.

The Road Board's Trials.

The speaker told how he had watched with interest the Road Board's trials along the Eltham-Sidcup road and elsewhere, and had visited the trial strips at a good many stages of their history, and has studied the interim reports. Were he to make a special report of his own he should say that the success of each individual strip has depended, and depended only, upon the hold which the binder has maintained upon the stones. Some of the strips are most certainly worn out, but in every case it has been the binding which has ceased to hold the stones, and not the stones which have collapsed within the binder. In these trials, and, indeed, elsewhere, the patent "Tarmac," made up of furnace slag (a road stone which, as a geologist, he could never place higher than third class), takes a high place, and he opines that the chief reason for its success is to be found in the circumstance that the slag, cooled directly from the state of fusion, can never have had any water spread or condensed upon its surface. Other successful aggregates are those in which the stones have been heated above the boiling point of water before they are mixed with the binder. By this heating the stones must of necessity be made dry, and hence, if the binder will spread upon them, a successful junction is assured. Next best are the processes by which boiling tar, pitch or bitumen is mingled with cold stones, but the removal of water by this means is never complete, and the method, as a rule, is not quite satisfactory.

The formula adopted by the British Cork Asphalt Company interests Professor Fearnsides. It excludes a certain quantity of Portland cement, and he was anxious to know why. It occurred to him that cement is an excellent dehydrating or drying agent, so he tried some experiments which lead him to believe that cement sprinkled over the surface of damp stones licks up the water, and makes it possible for tar or asphalt to spread over and make firm contact with the stones. About a year ago he wrote to one in authority suggesting that this method of chemical drying ought to be tried, but was given to understand that the cost would be prohibitive. Personally, he thinks otherwise, and is convinced that if those whose business it is to make tar or pitch macadam will dry their stones by mixing with them a little quicklime before the carbonaceous binder is added, the increased efficiency of contact between stones, the binder will more than repay the increase of cost.

Conclusions.

(1) The chemical action of water upon materials in roads is small as compared with the rate of mechanical wear, but care should be exercised in choosing materials which are to be buried in road foundations. Furnace slag for this purpose is not above suspicion.

(2) The power of water to bind is an effect of surface tension, and for maximum strength and efficiency it is important that the proportion of water should be kept at the optimum; "as dry as it can be drained" is the first approximation to the optimum for most water-bound road materials. Potholes grow by the wear of traffic at those places where by local water-pockets the proportion of water is kept above the optimum.

(3) Certain site-rocks, the argillaceous or clay rocks, owe their strength to water binding, and are subject to the same conditions of optimum water content. The importance of cambering and draining the site is, therefore, equal to that of arranging the configuration of the road surface.

(4) The effects of dew, more especially the dew which distils from below, are noteworthy, and in this, as in the question of the strength of the road, the importance of complete sub-crust drainage is to be emphasized.

(5) Water among solids which it does not wet acts as an insulator, and in the making of tar, pitch, asphalt or bitumen macadam should be rigorously eliminated

before stones and binder are brought together. The feasibility of chemical drying by adding to the partially dried stones a suitable proportion of quicklime or unslaked cement is suggested.

Summarily it is concluded that for each and every road aggregate there is a characteristic optimum proportion of water, which, for efficient service of road user, the road maker cannot afford to disregard.

COAST TO COAST.

Saskatoon, Sask.—The report for the light department for November showed that 143 new light services and nine new power services were installed, which is the largest increase shown in this department for some time.

Edmonton, Alta.—The street railway department reports a deficit of $13,000 for the month of November, 1913, as compared with a deficit of about $5,000 for the same month in 1912.

Souris, Man.—Mayor Dolmage formally opened the new light and power plant at Souris on December 20th in the presence of many of the citizens by throwing the switch that turned the current on to the standard lights on both sides of Crescent Avenue.

Edmonton, Alta.—After having reduced the cost of power to the electric light and street railway departments of the city, a sum equivalent to $6,601.80, during the month of November, the power house is still showing a net surplus for this month of $9,835.45.

Red Deer, Alta.—The steel on the C.P.R. line to the Brazeau coal fields, west from Red Deer, has reached a point west of Sylvan Lake, and will be completed to the Rocky Mountain House this winter. The C.P.R. has received running rights over the C.N.R. from the latter point to Brazeau.

Saskatoon, Sask.—The report from the civic electric light department for the month of November showed an increase of $4,570.60 in the income of the department and a reduction in the cost of producing power. In October the cost of producing power was 1.97 cents per kilowatt hour; in November, 1.93 per kilowatt hour.

Victoria, B.C.—The track-laying gangs of the C.N.P. from Edmonton have crossed the British Columbia boundary, steel having been laid some five miles westward up the Yellowhead Pass, 252 miles from Kamloops. North of Kamloops 96 miles of steel is laid, leaving only 156 miles as a final link.

Moose Jaw, Sask.—The rumor that the new C.P.R. passenger terminal was to be built at Moose Jaw this year has been denied officially. It is also understood that the new shops which were asked for will not be built this year; and from an official source the statement is made that very little work will be undertaken by the C.P.R. in Moose Jaw during the coming summer.

Forest, Ont.—On December 23rd, Mayor Pettypiece closed the switch that set in motion the new electric light service established this year in Forest. The plant has cost more than $20,000, and is the first public utility installed by the town. It is expected that it will prove to be a paying investment from its inception, and that a waterworks system will be the next undertaking of the municipality.

Prince George, B.C.—On the 10th of December the G.T.P. steel reached mile 200, which is 32 miles from Prince George; and it is expected it will be at the Fraser River opposite Prince George about the end of January. The driving of the last spike of the main line is announced by Mr. B. B. Kelleher, chief engineer for the G.T.P. company for next April, and the place as somewhere about 100 miles west of Fort George.

St. Catharines, Ont.—In connection with the $50,000 bonus to the Canadian Northern, it has developed that the company intends completing the line from St. Catharines to Hamilton within three years, and the section from Hamilton to Toronto within five years. An assurance to this effect has been given by Solicitor Temple on behalf of the company.

Victoria, B.C.—Work is progressing favorably along the line of construction on the Pacific Great Eastern. Mr. McQueen, purchasing agent for the company at Lillooet, speaks optimistically of the year's work, and indicates that expectations will be more than realized. Contrary to statements issued on the outside, he declares that the supply of labor is excellent, and the construction work is proceeding quickly.

Victoria, B.C.—A quantity of equipment for Victoria's electric light station has arrived, and mill permit of 100 additional arc lights being operated. Many of these lamps are now in position, but, owing to the redistribution of the circuits and the delay in the arrival of the new station apparatus, have not been put in operation. City Electrician Hutchison had had men at work all year rearranging some of the circuits, which have geen loaded to their full capacity, and on which no more new lights could be placed. These changes will provide for better facilities, especially in the northern sections of the city, and in the more remote outlying sections.

Ottawa, Ont.—The Government, through the National Transcontinental Railway Commission, has entered into a 99-year agreement with the C.P.R. and the G.T.P. for a union station at Quebec in connection with the National Transcontinental Railway. The new station is to be on the present site of the Palais Station, and will cost about one million dollars. Another union station, to accommodate St. Lawrence River traffic, will be built on the present site of the Champlain Market; and a tunnel will be built from Wolfe's Cove along the waterfront, giving railway entrance from the west for the National Transcontinental. The latter project will cost about $1,500,000.

Calgary, Alta.—The recent report of Superintendent McCauley shows that the proportion of operating expenses to revenue of the Calgary Street Railway for November, 1913, was 75.2 per cent. as compared with 68.4 per cent. for the corresponding month of last year. The total gross earnings were $60,670, a substantial increase over November, 1912, when the total was $56,233. Owing to the large increase in operating expenses, the net profit was $1,115.93 for November, 1913, contrasting with a net profit of $7,656.11 for November, 1912. A reduction in the cost of power of ¼ per cent. per kilowatt hour voted by council kept the net profits from appearing even still smaller than they were.

Victoria, B.C.—Recently, Mr. A. R. Tibbits of Ottawa, visited Victoria in the interests of the Marine and Fisheries Department of the Federal Government. His object was to collect first-hand information concerning the harbor conditions of Victoria and Vancouver; and, in response to an inquiry as to the merits of these ports, stated that:—"Victoria has a splendid natural harbor, easy to negotiate at all times, and capable of tremendous development; that the development is even now in progress; and that, when the work in progress is completed, the real significance of the port to the country will be better realized than it is to-day. The city of Vancouver is also wonderfully equipped in this respect.

Moose Jaw, Sask.—The result of the season's work at the headworks of the Moose Jaw system, all the water in the watershed at Sandy Creek can now be turned into the infiltration gallery, which has been completed to a total length

of 4,500 feet. The work upon the wells has not been as satisfactory. Contractor Duff has sunk a well 310 feet; but at this depth difficulty was met, and the casing bent, with the result that the whole work had to be undone. At present Mr. Duff is awaiting the arrival of a water jet with which he will endeavor to sink the well deeper. Another well, from which it was expected that a flow of 200,000 gallons per day would be secured, will be equipped with a pump very shortly, and the additional water will be added to the output of the system.

Edmonton, Alta.—Superintendent Parsons of the Edmonton waterworks department has estimated that in 1914 it will take $614,000 for the general operation of the plant, while $210,000 will be required for interest and sinking fund. The superintendent plans to make enough out of the plant to lay aside $100,000 for obsolesence fund. For the power plant, Superintendent Turner is asking for an expenditure of about $500,000 for new machinery and extensions; and estimates the revenue of the power plant as follows: for power sold to the electric light and power department, $504,726; for power sold to the street railway, $241,613; for pumping charges to the waterworks department, $176,982; making a total estimated revenue of approximately one million dollars.

Victoria, B.C.—Mr. H. A. Elgee, manager in Victoria, for the firm of Sir John Jackson, Limited, which is constructing the breakwater section of the Victoria harbor improvements, states that the progress to date is satisfactory in every way and that the work will be completed within contract time —December, 1915. About 300 men are engaged at present upon the work, either at Ogden Point, at the Albert Head branch, or on the office or general engineering staff. At the quarries, activity is now principally centred. Between 1,300 and 1,400 tons of rock are being taken out every day and deposited along the line of the breakwater, being transported to the harbor by five scows. And Mr. Elgee claims that it will not be long before the quarries will be so well developed that it will be possible to take out a much larger quantity of material than at present; that heretofore the work has been in every respect of a preliminary character; and that, anticipating this increase in the output of the quarries a new scow is being built for the work, while a steam hopper is being sent from Singapore. Another two months is expected to see the completion of the present operations which consist chiefly of depositing rock from Ogden Point out a distance of 1,000 feet, the object being to bring the breakwater up to a point 20 feet below low water mark. The character of this task can be appreciated when it is remembered that in some parts the water's depth is 70 feet. And, when this work is finished, the laying of granite blocks from Ogden Point out to sea, will commence.

Vancouver, B.C.—When unfolding to the waterworks committee recently the plan of the Federal Government for the development of False Creek, Mr. H. H. Stevens, M.P., said that the dredging facilities would be added to in order to complete the work of dredging the False Creek channel to a uniform depth and to a width of 350 feet; that it was the Government's intention to take over the old Kitsilano Indian Reserve of 80 acres and to develop it for public purposes, providing terminal facilities docks, piers, etc., for vessels and railways, in conjunction with the development of the creek; and that this would involve the expenditure of millions of dollars. While details of the whole scheme could not be outlined Mr. Stevens told the committee that the development work was very extensive, and that in view of this it would not be advisable to lay the Point Grey water main at a depth of 40 feet, which would, no doubt, interfere with the development scheme. However, when the plans had been worked out to completion it might be possible to devise a means of safely laying the pipes to a depth of 40 feet; and if the department thought that the laying of the pipe interfered with its plans, it would not grant permission for the pipes to be laid.

PERSONAL.

C. J. SIMMS, assistant division engineer of the Saskatchewan division of the Canadian Pacific Railway, with headquarters at Moose Jaw, has been appointed to a similar position in connection with the Vancouver division.

H. V. ARMSTRONG, who is at present on a brief holiday, returns to Estevan, Sask., next week as town engineer. Mr. Armstrong, a graduate in civil engineering of the University of Toronto, has spent 4½ years in Estevan, supervising the installation of a water supply, sewage disposal system, etc. The town will shortly go into the question of filtration of water supply.

H. B. WALKEM, who has been assistant division engineer for the Canadian Pacific Railway at Vancouver, B.C., for the past five years, and who, during 30 years of railway work in the West, has had charge of some prominent engineering works for the C.P.R., has been appointed engineer-in-charge of the Kootenay and Boundary districts, with headquarters at Nelson, B.C.

OBITUARY.

The death occurred recently of Mr. Alfred Williams, formerly associated with Mr. M. J. Heney in the construction of the White Pass Railway and of the Copper River and Northwestern Railway. Mr. Williams was president of the Ocean Shore Line, with headquarters in San Francisco.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Canadian Society of Civil Engineers, will be held at Montreal on January 27th, 28th and 29th. A later issue will contain details of the arrangements.

COMING MEETINGS.

MINING AND METALLURGICAL SOCIETY OF AMERICA.—Annual Meeting will be held in New York City, January 13th, 1914. Secretary, W. R. Ingalls, 505 Pearl Street, New York.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Annual Convention to be held in New York City, January 16th. Secretary, J. R. Wemlinger, 13 Park Row, New York City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual Meeting will be held in Montreal, Que., January 27-29. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal, Que.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21029—December 16—Requiring C.P.R. to stop its trains Nos. 1 and 2 at Biscotasing to accommodate local passenger and express traffic at said station, and that such stops be scheduled in company's timetable.

21030.—December 15—Authorizing C.N.R. to open for traffic from Blaine Lake to Denholm, Prince Albert-Battleford Line, Sask., a distance of 42 miles: Provided speed of trains be limited to a rate not exceeding 15 miles an hour.

21031—December 15—Authorizing C.L.O. & W. Ry. (C.P.R.) to operate over crossing of K. & P. Ry. at mileage 24.8, Glen Tay to Cobourg Line, pending installation of interlocking plant required under Order No. 16490; trains of C.L.O. & W. Ry. and K. & P. to be brought to a stop and flagged over the diamond.

21032—December 16—Approving revised location C.P.R. Snowflake Westerly Branch Line, from a point on East Boundary, Sec. 14, thence in westerly direction to point on West Boundary of Sec. 14-1-11, W. P. M., mileage 8.08 to 9.10. 2. Approving location of said Snowflake Westerly Branch Line, from point on West Boundary of Sec. 14, to point on West Boundary of Sec. 15-1-11, W. P. M., mileage 9.10 to 10.12 on said Branch Line.

21033—December 16—Authorizing C.P.R. to construct extension to existing spur for Port Haney Brick Co., Limited, Haney, B.C., subject to terms of consent of Municipality of Maple Ridge.

21034—December 17—Authorizing C.N.R. to construct spur from main line, across Elm St., through Block 113, Parkdale, city of Edmonton, Alta., for Messrs. Pray and McLennan.

21035—December 16—Relieving C.N.R. from speed limitation of 20 miles an hour required under Order No. 15380, on Moose Jaw Extension from Radville to end of track, a distance of 83 miles.

21036—December 15—Granting leave to Corporation of city of Edmonton, Alta., to extend Spadina Ave. across G.T.P. Ry.'s tracks, Edmonton; Railway Co. to be at expense of constructing and maintaining the crossing.

21037—December 18—Extending, until June 1st, 1914, time within which G.T.R. install electric bell at crossing of public road by Co.'s tracks, west of Ste. Justine Station, Que., required by Order No. 20964, dated Dec. 4th, 1913.

21038—December 18—Approving location Kettle Valley Ry. Co.'s line from mileage 27.23 to 50, from Hydraulic Summit westerly to Penticton, B.C.

21039—December 20—Authorizing Confederation Construction Co. to operate crossing of G.T.R. by means of a flagman until March 1st, 1914, or pending installation and completion of interlocking plant required under Order No. 20996.

21040—December 16—Authorizing C.L.O. and W. Ry. (C.P.R.) to operate trains over crossing of Whitby, Port Perry and Lindsay Branch of G.T.R., at mileage 163.46, town of Whitby, Ont., until June 1st, 1914, subject to condition that crossing be protected by watchmen appointed and maintained by and at expense of C.L.O. and W. Ry.

General Order—No. 115—December 19—Suspending, for the present and pending investigation by the Board, the following tariffs:—G.T.R. Co.'s C.R.C. No. E. 2858; C.P.R. Co.'s C.R.C. No. E. 2716; C.N.R. Co.'s C.R.C. No. E. 358; M.C.R. Co.'s C.R.C. No. 2162; T.H. and B. Ry. Co.'s C.R.C. No. 945; and O. and N.Y. Co.'s C.R.C. No. 989.

21041—December 18—Amending Order No. 20811, dated November 13th, 1913, by striking out figures "193" in third last line of recital to said Order, and substituting therefore figures "192½."

21042—December 19—Approving and authorizing clearances as shown on C.P.R. plan showing clearances at siding for Canada Linseed Oil Mills, Limited, situated in Lot Cadastral No. 1586 (civic and Cadastral) St. Mary's Ward, Montreal: Provided men be kept off sides of cars while operating said siding.

21043—December 20—Extending, until August 1st, 1914, time within which subway at Brock Avenue, Toronto, be completed.

21044—December 19—Relieving G.T.R. from providing further protection at crossing of Brant Street, Burlington Junction, Ontario.

21045—December 20—Authorizing G.T.R. to operate over subway at highway leading to Cardinal, Ont.

21046—December 20—Amending Order No. 19296, dated May 8th, 1913, by striking out words "a grade" in 4th line of paragraph 3 of Order, and substituting therefore words "an overhead."

21047—December 18—Directing G.T.R. to construct at Prairie Siding a small freight shed and platform to accommodate traffic offering, put present shelter for passenger traffic, in proper repair, make necessary arrangements to keep same in a clean and proper condition.

21048—December 17—Directing Dominion Atlantic Ry., at its own expense, to provide suitable farm crossing where it crosses property of R. V. Ditmars, of Deep Brook, N.S.

21049—December 20—Authorizing C.P.R. to construct siding for Stag Creek Lumber Co., Eastman, Que. 2. C.P.R. is authorized to construct, maintain and operate extension to present siding for said Stag Creek Lumber Co., to be completed within six months from date of this Order.

21050—December 10—Authorizing G.T.R. to construct sidings to serve premises of Imperial Wire and Cable Co., Limited, on part Lot 992, St. Anne's Ward, city of Montreal, Que.

21051—December 22—Authorizing C.N.O.R to construct bridge across South Branch of Petawawa River, Tp. Stratton, Dist. Nipissing, Ont., at mileage 121.9 west of Ottawa.

21052—December 19—Rescinding Order No. 20908, dated November 27th, 1913. 2.—Authorizing C.N.R. to remove branch line of railway on spur along Ninth Street, Brandon, between Victoria Avenue and Brandon Avenue, said city.

21053—December 22—Extending, until December 31st, 1914, time within which C.N.O.R. complete transfer track between its railway and G.T.R. in town of Port Hope, Ont.

21054—December 22—Approving plan "A" showing spans at C.N.O.R. bridge over Mink Creek, Tp. Pentland, Ont., at mileage 185.52 from Ottawa.

21055—December 22—Extending, until February 22nd, 1914, time within which C.P.R. complete spur, or switching lead, in city of Toronto, authorized by Order No. 20385, September 22, 1913.

21056—December 18—Approving location C.P.R. station at mileage 71.36 from Glen Tay, Lot 26, Con. 1, Tp. Thurlow, Co. Hastings, Ont.: Provided whenever traffic is blocked for more than 5 minutes at any one time by reason of location hereby approved, Board shall be at liberty to re-locate station.

21057—December 18—Approving proposed location C.P.R. station at St. Joachim, Lot 5, River Ruscom, Range West, Tp. Rochester, Co. Essex, Ont. And rescinding Order No. 19291, dated May 14th, 1913, granted herein.

21058—December 19—Authorizing C.P.R. to construct extension to existing spur lying southwesterly of Sherbrooke Street, and southeasterly of Harriott Street, Perth, Ont., for Henry K. Wampole and Co., at mileage 11.6, Ont. Div. Havelock Subdivision.

21059—December [illegible]—Authorizing C.P.R. to reconstruct Bridge No. 55.0 over Naiscootyong River, near Naiscoot, Ont.

21060—December 22—Authorizing C.P.R. to construct, by grade crossing, its passing track, on main line, Broadview Subdivision, across road allowance between Secs. 25 and 26-9-25, W.P.M., at mileage 25.45 on main line.

21061—December 22—Authorizing C.P.R. to construct, by grade crossing, its passing track, on main line, Broadview Subdivision, across road allowance between Secs. 22 and 23-9-24, W.P.M., at mileage 32.43 on said main line.

21062—December 22—Authorizing C.P.R. to reconstruct Bridge No. 1.9 on Prescott Subdivision, Eastern Division, Dist. No. 4 of its railway.

21063—December 22—Authorizing G.T.P. Ry., at his own expense, to construct across and divert highway in N.E. ¼ Sec. 1-27-15, W. 2 M., mileage 24, rural municipality No. 247, Dist. Saskatoon.

21064—December 22—Extending, until May 31st, 1914, time within which G.T.R. complete siding for Farquharson-Gifford Co., Limited city of Stratford, Ont., authorized under Order No. 19874.

21065—December 18—Relieving G.T.R. from providing further protection at crossing of public road 1 mile south of Brunner, Ont.

21066—December 22—Authorizing Kettle Valley Ry. Co. to construct four (4) bridges in British Columbia—namely, 1. Over Trout River Creek, at mileage 7 west of Penticton. 2. Over Trout Creek, mileage 36.8 west of Penticton. 3. Over Trout Creek, mileage 24.4 west of Penticton and 4. Over Trout Creek, at mileage 23.15 west of Penticton.

21067—December 22—Authorizing Government of Saskatchewan, to construct, at its own expense, highway crossing over C.N.R. at west end of station grounds at Pinkham, Sec. 28-28-25 W. 3 M., Sask.

21068—December 22—Approving location C.P.R. station in town of Milton, Co. Halton, Ont., at mileage 32.1, London Subdivision.

21069—December 22—Authorizing C.P.R. to take certain lands in town of Milton, Ont., for purpose of enlarging its yard.

21070—December 22—Authorizing C.P.R. to construct, extension to existing siding for Oliver Lemire, Cabane Ronde, Mascouche, Que., in Lot Cadastral, No. 155, Con. de Cabane Ronde, at mileage 15.88 from St. Martin Junction.

21071—December 20—Authorizing C.P.R. to construct spur with siding therefrom for Balsam Lake Quarries, Limited, Toronto, Ont., from a point on southerly limit of right of way at mileage 35.07 from Port McNicoll, Ont.

21072—December 22—Relieving G.T.R. from providing further protection at crossing of public road 1 mile south of Elmvale, Ont.

21073—December 22—Authorizing C.P.R. to construct spur for Kelley and Anderson, Bonfield, Ont., in Lot 10, Con. 8 Tp. of Bonfield, Dist. Nipissing, Ont., at Bonfield.

21074—December 22—Relieving G.T.R. from providing further protection at crossing of first public highway east of Glencoe, Ont.

General Order—No. 116—December 24—Suspending, for the present and pending investigation by the Board, increased minimum carload weights on buckwheat, oats bran (in bulk), dried beet pulp, oat hulls (in bulk), pea hulls (in bulk), chorts, beets (except sugar), onions, turnips and potatoes, as filled by Railway Companies subject to jurisdiction of the Board.

21075—December 22—Authorizing C.P.R. to construct spur for Imperial Supply Co., Limited, in Subdivision Lots 4, 5 and 6, Block 64, city of Calgary, Alta.

21076—December 22—Authorizing, C.P.R. to construct Bridge No. 94.4 for double-tracking, Toronto Subdivision, Don Viaduct; cost of alteration in work required by opening between pedestals be borne and paid by city of Toronto.

21077—December 23—Authorizing C.P.R. to construct sidings for Ontario National Brick Co., Limited, from a point on southeasterly limit of right of way at mileage 16.02, near Cooksville, in Lot 19, Con. 1, north of Dundas Street, Tp. Toronto, Ont.

21078—December 22—Authorizing C.P.R. to construct spur into premises of A. Morely, Lot 12, Con. 9, Tp. Huntingdon, Ont.

21079—December 22—Authorizing C.P.R. to open for traffic its Euffield-Blackie Branch from mileage 26.3 to 57.2, Alta.; speed of trains to be limited to rate not exceeding 15 miles per hour.

21080—December 22—Directing C.N.R. to fence its right of way in S.E. ¼ Sec. 21-7-25, W. 4 M., Alta.; work to be completed by May 1st, 1914.

21081—December 19—Extending, until June 30th, 1914, time within which Dominion Atlantic Ry. equip its locomotives with ash pans that can be dumped or emptied without the necessity of any employee going under such locomotive, except in cases of emergency.

21082—December 15—Extending, until July 1st, 1914, time within which C.P.R. equip its locomotives with ash pans that can be dumped or emptied without any employee going under such locomotive, except in cases of emergency.

21083—December 22—Authorizing Algoma Eastern Ry. to operate bridge at Little Current, between Goat and Manitoulin Islands, Ont.: Provided all trains come to a full stop at signboards and do not proceed over drawspan before signal is given by bridge operator.

21084—December 22—Authorizing Edmonton Interurban Ry. to operate cars and trains over crossing of Edmonton, Dunvegan and B.C., in N.W. ¼, Sec. 25-53-25, W. 4 M., Alta., without being brought to a stop; trains of Edmonton, Dunvegan and B.C. to be operated over said crossing at speed not exceeding 15 miles per hour.

21085—December 23—Authorizing Ontario Pipe Line Co., Limited, to lay gas pipe along, upon and across bridge over G.T.R. on Bay Street, Hamilton, Ont., subject to and upon certain conditions.

21086—December 24—Authorizing Canada Southern Ry. to cross with its industrial siding the industrial siding of G.T.R. leading to Canadian Steel Foundries, Limited, Tp. Crowland, Co. Welland, Ont., subject to terms and conditions contained in an agreement between Applicant and G.T.R.

21087—December 24—Ordering and adjudging that Board has jurisdiction to entertain application—of city of Hamilton for an Order compelling T.H. and B. Ry. to divert its entrance into city of Hamilton, via Hunter Street and adopt in conjunction with G.T.R. and C.N.O.R., a common location in north end of city, etc.—and to make an Order directing the deviation of line of T.H. and B. Ry., within the distance of one mile from its present location.

21088—December 23—Extending collection and delivery limits of Dominion Express Co., in city of Lethbridge, Alta.; and rescinding Order No. 16043, dated February 26th, 1912.

21089—December 23—Establishing collection and delivery limits of Dominion Express Co., in city of Vernon, B.C.

21090—December 26—Extending, until February 28th, 1914, time within which C.P.R. install bell at crossing of Main Street, village of Shelburne, Ontario.

21091—December 23—Authorizing C.P.R. to construct siding into premises of H. De Chiree, Lot Cadastral, No. 136, Con. St. Martin, parish of St. Felix de Valois, Co. Joliette, Quebec.

21092—December 24—Authorizing C.P.R. to operate bridge on Runnymede Road (Elizabeth Street), West Toronto, Ontario.

21093—December 24—Authorizing C.P.R. to operate bridge on Jane Street, Tp. York, Ontario.

21094—December 24—Extending, until January 15th, 1914, time within which G.T.R. install interlocking plant at Paris Junction, Ont.

21095—December 23—Approving location G.T.P. Ry. station at Tatlow, mileage 232.4, Prince Rupert East, Sec. 32-5-5, Coast District, B.C.

21096—December 26—Extending, until May 1, 1914, time within which C.P.R. complete subway at Dundas Street, Woodstock, Ont.

21097—December 26—Extending, until February 28th, 1914, time within which C.P.R. install bell at crossing of Main Street, Milverton, Ont.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

HOW THE STRENGTH OF WOOD IS TESTED IN CONSTRUCTION

A STUDY OF THE PROPERTIES OF THE VARIOUS KINDS IN USE—EFFECT OF MOISTURE CONTENT UPON STRENGTH—CONDITIONS AND NATURE OF TESTS — STRENGTH OF CANADIAN SPECIES

By A. H. D. ROSS,
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FROM time immemorial, wood has been used for construction purposes more than any other material, yet it is a curious fact that our information regarding its strength is not nearly so complete as in the case of steel, cement and other materials which have come into use in comparatively recent times. For a few kinds of wood our knowledge of their strength is fairly satisfactory, for a number of others it is still rather vague, whilst for the great majority of them it is almost a negligible quantity.

Selection of Material.—Every wood-worker knows that great variations occur in the appearance, weight, hardness and strength of any given kind of wood. For example, heartwood differs from sapwood, body-wood from limb-wood, butt logs from top logs, etc., etc., and it is therefore a matter of great importance to know the origin of the material being tested and the conditions under which it was grown. A piece of wood is not simply a material but a *structure*, just as much as a railroad bridge or a balloon frame, and as such varies greatly even in wood from different parts of the same tree. The fact of the matter is that it is almost impossible to understand the behavior of the material being tested without a somewhat intimate knowledge of its internal structure, because the size, character and arrangement of the tiny fibres composing it have a very important bearing upon its behavior when subjected to external forces. This is well illustrated in the case of weight, strength and hardness, which are closely related to the thickness of the cell walls. Unlike metals and artificial products with a homogeneous structure, such as steel and cement, wood is an exceedingly complex and heterogeneous structure, and it is therefore necessary to consider separately the stresses applied to it and the resultant strains.

Methods of Testing.—The strength of a piece of wood may be tested for: Elasticity; cross-breaking strength; endwise crushing strength; crushing strength across the grain; shearing strength; hardness; tension along the grain; or, torsional strength.

So far, most of the studies conducted have been for the determination of elasticity, cross-breaking strength, and endwise compression strength, whilst crushing strength across the grain, shearing strength, hardness, etc., have received comparatively little attention.

Whilst the various tests are made separately, it is, of course, evident that the fitness of wood for a given purpose depends upon a combination of several qualities. For example, railroad ties must be hard enough to resist mechanical abrasion, strong enough not to break and tough enough to prevent splitting and to hold spikes; a wagon spoke must be stiff, strong, hard, resilient and tough; furniture wood should be hard enough to resist indention, take a good polish, etc., etc.

Importance of Knowing Moisture Content.—One reason for dry wood being so much stronger than green material is due to the increased number of woody fibres to the square inch as the material seasons, and it is worthy of note that this increase in strength does not become apparent until the percentage of moisture falls below 40% of its kiln dry weight. The explanation of this lies in the fact that for more than 40% of moisture the water fills not only the cell walls but also the cell cavities themselves. As the weakening effect comes only from the wetting of the cell walls, it therefore follows that after they are fully saturated, any excess of water which occupies the cell cavity would be inoperative. Consequently, no increase in strength is noticeable until the cell walls themselves begin to dry out—after which the increase in strength takes place very rapidly, and becomes approximately two and one-half times that of the wood as it comes from the tree, as shown by the following figures (Table I.) by Tiemann:—

It should be clearly understood that the percentage of moisture is always calculated upon the weight of the wood when absolutely dry.

TABLE I.

	Bending Strength.		Endwise Crushing Strength,	
	12% Moisture.	3½% Moisture.	12% Moisture.	3½% Moisture.
Long leaf pine . . .	1.5	2.5	1.7	2.9
Red spruce	1.9	2.8	2.4	3.7
Chestnut . . .	1.6	2.1	1.8	2.8

Much of the pioneer work in testing the strength of wood is unreliable because sufficient care was not exercised in determining either the percentage of moisture present in the test pieces or their physical structure, both of which have a most important bearing upon the strength of wood. In fact it is only recently that these sources of weakness or strength have been studied exhaustively, and even yet an enormous amount of work remains to be done before our knowledge of the subject has been placed upon a satisfactory basis.

Previous to 1896 Johnson's figures for the strength of timber were based upon the assumption that it contained 15% moisture, but since then they are given for wood containing 12% moisture; as representing the condition of well-seasoned wood. In a dry-heated building the moisture content often falls as low as 8% or 10%.

Testing Laboratories.—In Europe many tests have been made by Bauschinger, Laslett, Tetmayer, Julius, Barlow, Tredgold, Warren, H. D. Smith and C. Graham Smith; whilst in the United States of North America the strength of several commercial species has been investigated by Johnson, Sharpels, Lanza, Tiemann, Thurston, Trautwine, Unwin and others. Unfortunately, however, the methods of testing and the varying percentages of moisture present in the specimens used have varied so much that it is impossible to reduce the results obtained by a number of these investigators to a satisfactory basis for comparison.

This whole subject of the strength of wood is of such importance to engineers and builders that in recent years the United States Forest Service has established wood-testing laboratories at Washington, D.C.; New Haven, Conn.; Madison, Wis.; Seattle, Wash., and a number of other places where the leading commercial species of the region are being investigated according to a uniform plan. From time to time, the results obtained are published in bulletins and circulars which may be obtained from the Superintendent of Documents, Washington, D.C., for a merely nominal charge.

Elasticity.—Elasticity refers to the ability of a horizontal beam of given dimensions to recover from a given amount of deflection, or "sag," when the force which has produced the deflection is removed, and is therefore closely related to stiffness. Obviously, pressure applied transversely to a beam of wood has a tendency to break the fibres across, and in modern testing machines is applied gradually to a system of levers by means of small weights or hydraulic pressure, and the force exerted upon the specimen is indicated by a delicately adjusted steel-yard. To avoid shearing along the grain the length of the beam should be ten to twenty times its depth, and to minimize the amount of crushing across the grain-bearing plates of the same width as the beam are used. The distance to which the middle point of the beam is forced down is termed its "deflection," and may be indicated by means of the letter d; the readings being taken to hundredths of an inch for large beams and to thousandths of an inch for smaller ones. For solid rectangular beams repeated tests have shown that the "modulus" or measure of elasticity varies directly as the pressure applied at their centre and the cube of the distance between the points of support, and inversely as their breadth and the cube of their depth. This explains the common practice of setting flooring joists on edge, which enormously stiffens the whole structure. For example, if the joists consist of 2 x 10-inch material, then setting them on edge and placing diagonal braces between them to keep them in position gives a floor $\frac{2}{10}$ of $\left(\frac{10}{2}\right)^3 = 25$ times as stiff as if they were laid flatwise. In practical engineering the load acts continuously and it has been found that the deflection for wooden beams should not exceed $\frac{1}{480}$ of their length; which would amount to only half an inch for a 20-foot beam.

Stress Diagrams.—When the deflections, in inches, are plotted on the horizontal axis of a sheet of cross-section paper and the number of pounds pressure required to produce these deflections are plotted on the vertical axis, it is found that the series of points obtained gives us a curve which is practically a straight line up to a point known as the "elastic limit"; beyond which it still continues to rise but soon curves away from the straight line to another point known as the "maximum load." After this it descends gradually because of the failure of the piece being tested, as is well shown in the accompanying diagram (Fig. 1) for a piece of fairly straight-grained red spruce having a span of 14 feet between the roller bearings and measuring 6 inches in width and 8 inches in height. From the diagram it will be noticed that the

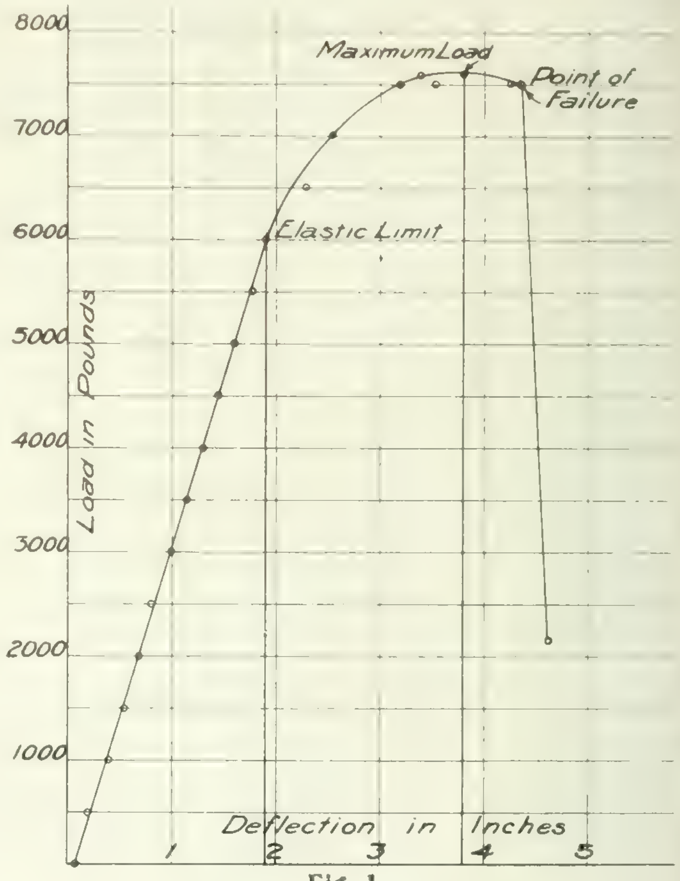

Fig. 1.

elastic limit was reached under a strain of 6,000 pounds and the maximum load at 7,580 pounds. Disks cut from the beam near the point of failure and dried in a steam-heated copper kiln showed moisture content of 25%, 33% and 42; according to the distance they were taken from the surface.

Modulus of Elasticity.—From the reading obtained at the elastic limit, the deflection observed at that pressure and the dimensions of the piece tested we may calculate what is known as the "modulus of elasticity" by means of the formula

$$E = \frac{w\, l^3}{4\, d\, b\, h^3}$$

where w represents the pressure in pounds midway between supports, d the deflection or "sag" in inches, l the number of inches between the horizontal supports, and b and h the breadth and height of the beam, in inches. Any

five of these quantities being known it is an easy matter to calculate the sixth. For example, in the case of our red spruce beam, 6,000 pounds pressure produced a deflection of 1.9 inches, whence we have

$$E = \frac{6,000 \times 168 \times 168 \times 168}{4 \times 1.9 \times 6 \times 8 \times 8 \times 8}, = 1,244,842.$$

Conversely, if we know the value of E and wish to calculate what weight will produce a sag of 2 inches in a red spruce beam similar to the one tested, but six inches square and having a span of ten feet, then we have the equation

$$1,244,842 = \frac{w \times 120 \times 120 \times 120}{4 \times 2 \times 6 \times 6 \times 6 \times 6}, \text{ whence } w = 7,469 \text{ lbs.}$$

Cross-breaking Strength.—When forced beyond the elastic limit the piece being tested acquires a permanent set and finally breaks at what is known as the "point of failure," or "maximum load." When this occurs the "modulus of rupture" is calculated by means of the formula $R = \frac{3\ W\ l}{2\ b\ h^2}$, which in the case of our red spruce beam gives us $R = \frac{3 \times 7,580,168}{2 \times 6 \times 8 \times 8} = 4,974.$

For bending tests of this kind the early experimenters used small pieces because of the difficulty in holding and bringing strains to bear upon larger ones. Bauschinger used beams 20 inches square and nine feet long with 98.4 inches between their supports. At the Massachusetts Institute of Technology, Lanza used beams varying from four to twenty feet long, from 2 to 6 inches in width and from 2 to 12 inches in depth. In Johnson's work on large beams, smaller pieces (measuring 4 inches square) were cut from the large ones as soon as they failed and were then tested to see whether the same *moduli* would apply, and this was found to be the case *whenever similar conditions existed.*

Many Tests Required.—On account of the great variations that occur in the weight of any kind of wood, the proportion of heartwood to sapwood, differences in minute structure due to different conditions of growth or of wood taken from different parts of the same tree, and the enormous variations that may occur in the moisture content of the test pieces, it is evident that reliable figures on the strength of wood must be based upon the average of a large number of tests. The following figures (Table II), for the cross-breaking strength of woods containing 12 per cent. moisture, show a wide range.

TABLE II.

Species.	No. of tests.	Highest single test.	Lowest single test.	Average of all tests.
Pignut hickory ...	30	25,000	11,000	18,700
Shagbark hickory .	187	23,300	5,700	16,000
White oak	218	20,300	5,700	13,100
Red oak	57	16,500	5,700	11,400
Red pine	95	12,900	3,100	9,100
White pine	120	11,800	4,600	7,900
White cedar	87	9,100	3,500	6,300

Effect of Permanent Loads.—Thurston experimented on small wooden beams one inch square and four feet long for the purpose of determining the effect of permanent loads on their strength as compared with the results obtained with testing machines, and found that 60 per cent. of the breaking load in the machine would break the beams if the load was left on them for nine months time. Later on Johnson experimented with well-seasoned wooden columns and came to the conclusion that "The ultimate strength of wooden columns is only about one-half the utilimate strength of those same columns as determined by a testing machine."

Endwise Compression.—The failure of a piece of wood under pressure along the grain is a very complex phenomenon. At first the fibres act like a number of hollow columns firmly bound together, but as the load becomes too great they tear apart and act as a number of independent pieces and finally bend over when the piece fails. In all test pieces it is advisable to have the length less than 15 times the least diameter, else they are liable to fail by bending sideways before the full load they are capable of sustaining is reached. A number of tests of West Australian timber showed that 60 per cent. of the columns having a ratio of 18 to 1 failed in this way, and every builder is familiar with the common practice of bracing the studding in a wall to prevent the failure of the upright pieces by sidewise flexure. The endwise compression strength of wood is given in pounds per square inch, and is read directly from the testing machine. Johnson says that the result of over 40,000 tests shows that 55 per cent. of the results fall within 10 per cent. of the general average and that 90 per cent. of them fall within 25 per cent. of the general average. This is a greater range of variation in strength than is usually found in other kinds of building material, and is partly due to variations in the structure of the wood itself. The following figures (Table III), illustrates some of the variations that occur.

TABLE III.

Endwise Compression, in Pounds Per Square Inch.

(For 12% moisture).

Kind of wood.	No. of tests.	Highest single test.	Lowest single test.	Average of all tests.
Pignut hickory ..	30	13,000	8,700	10,900
Shagbark hickory .	137	13,700	5,800	9,500
White oak	218	12,500	5,100	8,500
Red oak	57	9,700	5,400	7,200
Red pine	100	8,200	4,300	6,700
White pine	130	8,500	3,200	5,400

In spite of the complex nature of woody structures it is rather a surprise to learn that properly designed wooden columns will support a greater load than an equal weight of cast-iron or steel of similar proportions.

Crushing Strength Across the Grain.—A timber column is frequently designed for its maximum load and is then set on a sill of the same wood without knowing that the crushing strength across the grain is very much less than it is in the endwise direction. Many failures of timber structures are due to this cause alone. For very heavy loads, it is therefore, advisable to use caps and sill pieces to distribute the load and thus prevent crushing across the grain as much as possible. The crushing takes place layer by layer and woods with thin-walled fibres, like pine and spruce, give way sooner than those with thicker walls, such as oak and hickory. Furthermore, in woods containing large pith rays, like oak and sycamore, the crushing strength in the radial or "edge-grain" direction is greater than in the tangential or "slash-grain" direction. Naturally the greater the percentage of moisture present the more easily the wood crushes, as is well illustrated in Table IV.

TABLE IV.

Kind of wood.	Percentage moisture.	Pounds per square inch.	Percentage moisture.	Pounds per square inch.
Shagbark hickory ...	58	1,080	9.8	2,717
Sugar maple	56	870	12.5	1,755
White oak	78	1,004	11.4	1,685
Rock elm	46	696	11.2	1,605
Yellow birch	72	459	10.5	1,340
Black oak	80	802	11.4	1,240
White ash	47	801	11.2	1,292
Beech	61	665	13.0	1,185
Red oak	80	807	11.9	1,100
Tamarack	52	480	11.0	1,080
Red pine	54	358	12.5	833
Western yellow pine ..	125	320	9.7	805
Lodgepole pine ...	46	364	11.0	779
Douglas fir	32	427	12.0	744
White pine	75	314	9.9	757
Western hemlock	129	420	9.5	726
Red spruce	31	322	12.9	531
White spruce	41	262	12.0	455
White cedar	55	288	11.2	389

Shearing With the Grain.—Shearing strength refers to the force required to push a piece of wood in the direction in which its fibres run, and has its practical application in the strains exerted on mortise and tenon structures. The lighter conifers and hard woods shear more easily than the heavier kinds, and the best of pine from one-third to one-half as easily as hickory or oak. Surfaces parallel to the annual rings shear more easily than those parallel to the pith rays and green wood about one-third as easily as dry wood. Table V. shows the shearing strength of ten well known woods which have been kiln dried and contain specified percetages of moisture.

TABLE V.

Kind of wood.	Percentage of moisture.	Shearing force (pounds per square inch).
Shagbark hickory	9.6	2,290
Bitternut hickory	9.7	2,048
White oak	12.1	2,165
Black oak	11.6	2,005
Red oak	11.2	1,845
White ash	10.8	1,522
White elm	10.8	1,447
Red pine	12.5	1,262
White pine	9.9	1,072
White cedar	11.2	902

Hardness.—From the carpenter's point of view, hardness refers to the resistance of the fibre of wood to axe, saw, chisel or plane, and will depend upon such factors as density, moisture content, etc. Wide rings in oak and narrow rings in pine increase the hardness; heartwood is harder than sapwood; and, dry wood is harder than green wood—excepting willow and poplar. The static test for hardness used to be to note the number of pounds pressure per square inch required to force a square die into the wood to a depth of one-twentieth of an inch, but as this included shearing across the grain for two edges of the die and shearing along the grain for the other two edges the method now adopted is to record the number of pounds pressure required to force a steel ball .444 inches in diameter into the wood a distance equal to half its own diameter. Such tests show that wood is harder in an endwise direction than it is across the grain. Partly for this reason, but mainly because the endwise crushing strength of wood is much greater than its crushing strength across the grain, it is customary to set paving blocks on end.

Table VI., for the hardness of 16 well-known woods, exhibits, in a rather striking manner, how very much harder any kind of well-seasoned wood is than the same material as it came from the tree.

TABLE VI.

Kind of wood.	Percentage moisture.	Pounds pressure required to imbed a .444 inch ball to ½ its own diameter. Endwise.	Sidewise.
White oak	62	1,087	1,048
	12.8	1,520	1,487
Sugar maple	57	992	910
	10.3	1,942	1,346
Yellow birch	72	827	754
	10.3	1,542	1,280
Rock elm	46	954	888
	11.2	1,593	1,257
Beech	61	1,012	908
	[illegible]	1,463	1,217
Black oak	80	847	795
	11.4	1,598	1,208
Black ash	77	566	544
	11.6	1,101	792
Tamarack	52	401	375
	11	725	636
Douglas fir	32	415	406
	12	723	616
Red pine	54	355	342
	12.5	696	596
Red spruce	12.9	648	510
White spruce	12.6	526	494
Lodgepole pine	44	288	312
	11	503	533
White pine	74	304	296
	9.9	611	469
Western yellow pine	98	310	314
	11.6	546	408
White cedar	55	321	226
	11.2	466	338

Tension Along the Grain.—The tensile strength of straight-grained wood is very high and hard to measure because of the difficulty of preventing the ends of the test pieces from slipping in the shackles of the testing machine. However, it is not often that a wooden beam is used for a tie bar. For rock elm the tensile strength along the grain is approximately 28,000 pounds, or 3.8 times its endwise crushing strength; for shagbark hickory 32,000 pounds, a ratio of 3.4; for tamarack 19,400, or 2.5; and for long-leaf pine 17,300, or a ratio of 2.2 to 1. Hence, in a general way, we may say the tensile strength of the tougher woods is approximately three times their endwise compression strength.

The tests of most interest to the architect and the engineer are those for cross-bending, crushing and shearing. Long before the timber would give way in tensile strength the bolts or connections would shear through the ends of the timber, and for this reason it is customary to place them at least three or four inches from the ends of the beam required to bear tensile stress.

Torsional Strength.—The torsional strength of wood refers to the ability of its fibres to withstand twisting and is measured by securely fastening one end of the rod at one end of a lathe and clamping the other end in a wheel which can be rotated until the fibres of the wood are completely twisted and torn asunder. Hickory, rock elm, blue beech and willow possess this property in a marked degree.

Flexibility.—This property depends upon the toughness and cohesive force of the woody fibres, the percentage of moisture present, the temperature and the amount of natural or artificial impregnation. Wood from the base of the tree is more flexible than that obtained higher up, and hardwoods are generally more flexible than conifers. For all kinds of wood, moisture and heat soften

it and increase its flexibility, as is well illustrated in the manufacture of bent-wood furniture, barrel staves and hoops, the bending of wooden rims for wheels, veneer peeling, etc.

Toughness.—This is a more or less general term applied to woods which are both pliable and rather difficult to split. When the dry wood permits of an aggregate distortion in compression and tension of at least 3% and resists a longitudinal shearing force of 1,000 pounds per square inch it may be pronounced "tough," as for example, hickory, ironwood, oak, elm, ash.

Resilience.—This term is often confused with toughness and may be defined as ability to withstand impact, and explains the use of oak and hickory for wagon spokes, where each spoke is dealt hundreds of terrific blows in a mile journey over a rough road. Maple, beech, hawthorn and dogwood also have a high resilience.

Weight and Strength.—Broadly speaking, the strength of well-seasoned wood increases with its weight per cubic foot, the exceptions being confined mainly to the oaks which have an exceedingly complicated structure. To state the case more accurately, we may say, the higher the density of the wood the greater is its crushing strength, although density is no criterion of tensile strength.

Effect of Long Immersion in Water.—Sixty-five tests on alternate sections of the same sticks tested in the regular way indicate that soaking in water for six months produces no apparent loss of strength. Whilst soaking in cold water does not diminish the strength of wood, it is a well-known fact that heating the water weakens it considerably and boiling the water causes a still greater dimunition in strength, as noted already under the heading of flexibility. Timber which is first kiln dried and then soaked in water is found to be weaker than air dry timber containing an equal percentage of moisture, and fails much more suddenly because kiln drying increases the permanent brittleness of wood.

Effect of Hot Air Drying.—Apart from the checking action which results from a too rapid drying of the exterior portions of the test pieces, the result of over 200 tests shows that with the temperatures commonly used for drying lumber no detrimental effect was observed on the strength of the material.

Effect of Creosoting.—The following figures (Table VII.) for compression tests made on pieces of loblolly pine which had been soaked in water and in creosote for six days are interesting:

TABLE VII.

	Length of soaking (days).	Moisture %.	Relative load.
Air dry wood	0	9.1	1.00
Soaked in water	6	71.5	.42
Soaked in creosote	6	[illegible]	.80

These figures show that creosote diminished the strength of the wood approximately one-half as much as soaking in water. It should be remembered, however, that these tests were made on very small pieces, and the results should be received with caution. More recent experiments show that whilst the strength decreases immediately after being creosoted this decrease is only temporary. Apparently the presence of creosote does not of itself weaken the wood but only retards the seasoning process, so that after a time it should become as strong as the original seasoned wood.

Safety Factors.—On account of such defects as knots, season checks, star-shake, etc., present in most structural timber and the great variation constantly occurring in its moisture content, it is customary to design timber structures so that they will carry several times the load ordinarily required—this multiplier being known as a safety factor. In the case of ordinary timber structures a safety factor of four is generally sufficient, provided the modulus of rupture has been determined from a large number of tests on fairly large-sized pieces, but in the case of structures carrying moving or jarring loads (bridges and foundations for machinery) a safety factor of five or six should be allowed.

In 1896 a committee of the American International Association of Railway Superintendents of Bridges and Buildings recommended the following factors: For timber in shearing and compression across the grain, 4; for columns under 15 diameters high and for end bearing, 5; for extreme fibre stress in transverse rupture, 6; in tension with and across the grain, 10.

Testing of Canadian Woods.—Because of the importance of this subject to all classes of wood users, the Forestry Branch of the Department of the Interior is about to undertake an exhaustive series of tests at McGill University. Beginning with a few of the more important of the commercial species, every kind of wood in the country will be tested for its strength in various ways, and for different conditions of growth and moisture content. At present the only information we have on this subject is based upon tests of wood grown in the United States; many of which were grown under entirely different conditions to what we find in our own country.

Provisional Table.—In the absence of more satisfactory information, the writer has therefore compiled the following table (Table VIII.) for 84 species of wood found growing in Canada. The necessary information has been gleaned from numerous sources and will be of considerable assistance to the designers of timber structures until such time as the Forestry Branch has completed its investigations along this line and furnishes fuller information regarding the strength of our native woods.

(Continued on following page.)

CANADIAN FOREST FIRES IN 1913.

The Forestry Branch, Department of the Interior, announces that the loss of timber by fire in Western Canada was smaller during last season than ever before. On several of the reserves in Manitoba and Saskatchewan fire occasioned no damage whatever, and on the Dominion reserves in the Railway Belt, B.C., the only green timber injured by fire was four acres of young lodgepole pine. Even on the Rocky Mountains reserve in Alberta, with the immense area of 13,373,856 acres, most of which is remote from settlement, fire destroyed only 1,150 acres of young timber, whose present value was small, and mature timber to the value of $150. The total area burnt on this reserve was but two one-hundredths of one per cent. of the above acreage, and it is likely, when the reports are complete from the other reserves, which are smaller and usually better protected, that the aggregate area burnt over by fire will be no greater than one one-hundredth of one per cent. of the total reserved area. The significance of this figure is apparent by comparison with the corresponding figure for the National Forests in the United States, where the area burnt over by fire in 1913, although admittedly the smallest in recent years, was about 0.03 per cent. of the total area.

TABLE VIII.

Kind of Wood	Kiln Dry Weight (Pounds per Cubic Foot)	Percentage Moisture, (Based on Dry Weight)	Number of Tests Made	Modulus of Elasticity $E = \frac{wl^3}{4dbh^3}$	Modulus of Rupture $R = \frac{3wl}{2bh^2}$	Endwise Compression Strength (Pounds per Square Inch)
Ash, Black	33	91	6	1,107,000	6,000	2,340
	..	11.6	6	1,395,000	11,620	5,590
	39	12	.	1,230,000	11,400	.....
" Blue	38	39	5	1,241,000	9,650	4,180
	45	12	8	1,108,000	11,500	7,070
" Green	39	48	5	1,480,000	10,040	4,360
	44	12	10	2,050,000	11,600	8,000
" Oregon	36	12	8	1,200,000	9,400	7,360
" Red	39	12	3	1,154,000	12,300	6,160
" White	44	40	5	1,635,000	10,760	4,630
	39	12	87	1,640,000	10,800	7,200
Basswood	22	110	5	842,000	4,450	1,820
	..	9.2	5	1,674,000	7,310	4,770
	28	12		1,190,000	8,300	.....
Beech	42	61	5	1,353,000	8,610	3,480
	..	13.1	5	1,830,000	14,830	6,450
	43	12	10	1,720,000	16,300	6,765
[illegible] Birch	45	12	4	1,160,000	16,300	7,075
Birch, Cherry	44	61	5	1,490,000	8,590	3,560
" Paper (Canoe)	37	12	12	1,185,000	15,000	6,885
Birch, White (Gray)	35	12		1,036,000	11,000	.....
" Yellow	41	72	5	1,597,000	8,390	3,400
	..	10.3	5	2,396,000	19,400	9,560
	41	12	..	2,290,000	17,700	.....
Butternut	25	102	5	1,008,000	5,870	2,580
	25	12	9	1,150,000	8,400	5,545
Cedar, Red (Pencil)	31	12	13	950,000	10,500	5,805
" Western, Red	23	12		1,460,000	10,600	.....
(Shingle)	20	55	5	643,000	4,250	1,990
" White	19	12	87	750,000	6,300	5,200
" Yellow	29	..	..	1,460,000	11,000	.....
Cherry, Black	33	55	5	1,308,000	8,030	3,540
	36	12	.	1,200,000	11,700	.....
" Wild Red	..	46	5	1,042,000	5,040	2,170
Chestnut	28	12	..	1,260,000	9,500	5,550
Cucumber	29	80	5	1,535,000	7,420	3,140
	..	12	8	1,310,000	9,500	7,570
Dogwood, Flowering	50	62	5	1,175,000	8,770	3,640
	51	12	.	1,160,000	12,800	...
Elm, Rock	45	46	5	1,222,000	9,430	3,740
	..	11.2	5	1,755,000	16,350	7,570
	..	12	7	2,550,000	15,100	8,380
	40	57	5	1,314,000	9,510	3,000
	..	11.6	5	1,622,000	13,950	7,080
Elm, Slippery	43	12	..	1,300,000	12,300	....
" White	34	66	5	1,052,000	6,940	2,700
	..	10.8	5	1,504,000	12,140	5,840
	..	12	18	1,540,000	10,300	6,500
Fir, Alpine	20	47	5	861,000	4,450	2,050
		15.9	5	887,000	5,960	3,400
" Balsam	24	12	1	1,160,000	7,300	5,175
" Douglas	29	32	5	1,242,000	6,340	2,920
	..	12	5	1,392,000	9,320	6,050
	32	.		1,680,000	7,900	....
" Lovely	24	117	14	1,323,000	6,570	3,040
" Lowland	22	12	..	1,360,000	7,000	.....
Gum, Black	30		11	1,190,000	11,800	6,630
Hackberry	35	50	1	1,170,000	7,800	3,320
	..	11.4	.	1,426,000	14,070	7,250
	45		10	1,149,000	11,700	5,960
Hawthorn, Pear		74	2	[illegible]	7,650	3,110
Hazel, Witch	45	—	5	1,112,000	8,280	3,400
Hemlock, Eastern	25	120	5	917,000	5,770	2,750
	..	9.5	5	1,048,000	7,510	5,740
	26		20	1,270,000	10,400	5,565
" Western	32	52		1,428,000	7,290	3,390
	.	12		1,666,000	10,370	5,400
	32	12	.	1,746,000	12,800	7,740
Hickory, Bitternut		65	11	1,399,000	10,280	4,570
	..	9.7	11	1,880,000	18,850	10,600
	.	12.0	25	......	15,000	9,600
" Mockernut	41	57	11	1,508,000	11,110	4,320
	..	9.2	11	2,555,000	21,950	10,400
	..	12.0	75	.....	15,200	10,100
" Pignut	.	55	5	1,605,000	4,820	11,450
	..	9.5	5	2,370,000	11,130	24,000
	56	12	30	2,730,000	18,700	10,000
" Shagbark		58	9	1,346,000	4,360	10,990
	..	9.8	9	2,120,000	10,500	22,600

TABLE VIII. (*Continued.*)

Kind of Wood	Kiln Dry Weight (Pounds per Cubic Foot)	Percentage Moisture (Based on Dry Weight)	Number of Tests Made	Modulus of Elasticity $E = \frac{wl^3}{4dbh^3}$	Modulus of Rupture $R = \frac{3wl}{2bh}$	Endwise Compression Strength (Pounds per Square Inch)
Hickory, Shagbark	51	12	187	2,390,000	16,000	9,500
Hop, Hornbeam, (Ironwood)	51	12	6	1,950,000	[illegible]	[illegible]
Larch, American, (Tamarack)	35	52	5	1,230,000	7,170	3,480
	..	11	5	1,680,000	12,050	7,590
	38	12	14	1,790,000	12,800	7,470
" Western	..	46	..	1,310,000	7,250	3,700
	..	14.8	..	1,565,000	10,230	[illegible]
	46	..	6	2,300,000	17,400	9,755
Locust, Black	45	..	9	1,830,000	18,100	[illegible]
" Honey	47	53	3	1,732,000	[illegible]	[illegible]
Madrone (Arbutus)	43	.	4	[illegible]	12,000	8,835
Maple, Ash-leaved, (Box Elder)	27	..	4	820,000	[illegible]	[illegible]
" Broad-leaved, (Oregon)	30	..	..	[illegible]	9,720	...
" Red	..	69	..	1,445,000	8,310	3,680
	..	12.1	..	1,761,000	13,420	6,610
	38	..	9	1,340,000	15,000	6,550
Maple, Silver	32	60	5	943,000	5,820	2,490
	..	12	1	1,570,000	14,400	6,820
" Sugar	..	56	5	1,437,000	8,820	4,000
	..	12.5	5	1,930,000	14,830	[illegible]
	43	..	9	2,070,000	16,300	[illegible]
Mulberry, Red	36	..	..	1,700,000	11,000	....
Oak, Black (Yellow)	..	80	5	[illegible]	7,650	3,080
	..	11.4	5	1,641,000	14,670	7,120
	45	12	49	1,740,000	10,800	7,300
" Burr	42	70	5	877,000	7,180	3,280
	46	12	13	1,320,000	13,900	6,950
" Chestnut	47	12		1,780,000	14,600	.....
" Pin	43	12	..	1,500,000	15,400	.....
" Red	..	89	6	1,248,000	8,100	3,440
	..	10.5	6	2,000,000	14,400	8,150
	45	12	57	1,970,000	11,400	7,200
" White	44	58	5	1,137,000	8,090	3,520
	..	10.5	5	1,595,000	13,900	7,580
	..	12.0	218	2,090,000	13,100	8,500
" Swamp, White	49	74	1	1,593,000	9,860	4,960
	..	19.2	..	2,020,000	19,210	8,030
" Western White, (Garry)	46	.	..	1,150,000	12,400	.....
Pine, Jack	30	.	6	1,332,000	9,100	5,600
" Limber	27	..		961,000	8,800	4,950
" Lodgepole	26	44	5	1,015,000	[illegible]	2,530
		11	5	1,270,000	8,740	5,520
	..	..	5	1,099,000	[illegible]	4,715
Pine, Red	32	54	5	1,384,000	6,430	3,080
	..	12.5	5	1,787,000	12,300	7,080
	31	12	95	1,620,000	9,100	6,700
" White	24	74	5	1,073,000	5,310	2,720
	..	9.9	5	1,417,000	9,620	6,360
	..	12	[illegible]	1,390,000	[illegible]	[illegible]
" Rocky Mountain White	27	12		937,000	8,700	...
" White-barked	26	[illegible]	2	729,000	5,150	4,685
" Western White	24	12		1,356,000	8,700	
" Western Yellow, (Bull)		80		[illegible]	7,650	3,080
	..	11.4		1,641,000	14,670	7,120
	29	12		1,260,000	10,200	...
Poplar, Aspen	26	96		1,185,000	5,850	2,720
	.	12	4		.	[illegible]
" Large-toothed Aspen	28	12		1,360,000	10,200	[illegible]
" Cottonwood	24		7	1,400,000	10,900	[illegible]
" Black Cottonwood	[illegible]		4	1,580,000	8,400	[illegible]
Sassafras	31			[illegible]	8,500	
Spruce, Black	28	12	[illegible]	1,560,000	8,400	[illegible]
" Engelmann	22	45	[illegible]	866,000	[illegible]	2,170
	..	12.8	5	1,074,000	[illegible]	[illegible]
	21	12	4	1,140,000	8,100	[illegible]
Spruce, Red	22	31	[illegible]	[illegible]	5,820	2,920
		12.9	4	1,574,000	10,340	[illegible]
	..	12	[illegible]	[illegible]	8,400	[illegible]
" White		[illegible]	2	[illegible]	5,200	[illegible]
	..	12.6	2	[illegible]	9,210	[illegible]
	25	12	10	1,450,000	[illegible]	[illegible]
Sumach, Staghorn	28	[illegible]	5	[illegible]	[illegible]	[illegible]
Sycamore, (Button ball)	[illegible]	81	5	[illegible]	[illegible]	[illegible]
	..	11.5	5	[illegible]	[illegible]	[illegible]
	35	12	4	1,220,000	[illegible]	6,370
Tulip, (Yellow Poplar)	26			1,300,000	[illegible]	
Walnut, Black	38		5	[illegible]	[illegible]	
[illegible]	26	148	5	[illegible]	[illegible]	[illegible]
	27	12	2	[illegible]	[illegible]	[illegible]

FACTORS GOVERNING THE SELECTION OF A ROAD SURFACE OR PAVEMENT.*

By L. R. Grabill,
Superintendent of Suburban Roads, Washington, D.C.

THE selection of a pavement or road surface is one of the most important of the duties of a highway engineer. The surface of the road or street, equally with the bridge truss or the retaining wall, should be neither over-designed nor under-designed as to the strength required to satisfy the conditions which it will be called upon to meet. In this particular the discrimination and care used must be similar to that of the architect in choosing the type of building suited to the case he has in hand, and to that of the bridge engineer in selecting the kind of bridge he will use. The roadbuilder or the pavement engineer must choose not only the type of surface which will be the easiest over which to pull a load, which will prove durable under the traffic that it will carry, and which will be adapted to the numerous local conditions; but he must, if his work is properly done, choose the surface that will produce these results with the minimum final cost both to the users of the road and to the community which pays for its construction and maintenance.

Nothing could be easier than to select a few types of road suitable to a few locations, and to adhere to these types, regardless of wide variations in the conditions; and this, it is feared, is too often done. It is very much on the safe side to assume that the character of pavement required for the most exacting purpose should be used for very different and lighter requirements; or to assume that the surface which costs the most will necessarily be the best; but it is not always possible to decide with such facility the question of what surface will prove the most satisfactory, under the special conditions involved, for the lowest total expenditure per ton carried over it. Yet this is the question to be solved in every new construction.

There is frequently the danger, too, that a lack of sufficient funds for the work proposed will cause the effort to be made to cheapen the first cost of construction beyond the limit necessary for durability; and it is not often that the road engineer finds enough funds available to build a better road than he wishes, if indeed he is able to build as well as his judgment dictates. In these cases, however, it is usually possible to limit the area covered, either in length or width, or both, so that a suitable character of surfacing may be employed.

It is assumed here that all of the necessary requirements for the sub-grade have been met, such as those that relate to grade, drainage, and the preparation of the earth foundation for the pavement. These being the necessary and most permanent part of the road, should always be well done, in the best and most enduring manner that is practicable with the funds available, even at a sacrifice of the character of the surfacing, which will in time require renewal under any circumstances.

In considering the question from a purely academic standpoint, the availability of the funds necessary for constructing the kind of surface required for any given case may be also assumed, so that the question of cost presents itself only as a factor of the problem, and not as a limiting feature of the selection. This assumption is necessary, because if sufficient money cannot be obtained, the question becomes one of the selection not of the proper surface, but of the best one that can be paid for; forming a somewhat different problem, with greater limitations. In fact, the entire question may be said to cover two classes of cases, namely, those which are not limited by some special consideration, such as cost, grade, etc., and those which are so limited. The latter class is more frequently met with.

The word pavement is used by the writer for any class of hard surfacing of the road or street.

Mr. A. T. Byrne, in his work on Highway Construction, names the following as the essential qualities of a good pavement: Imperviousness; durability; freedom from slipperiness, noise, dust and mud; adaption to every grade and to every class of traffic; ease of cleaning; minimum resistance to traction; cheapness.

Mr. G. W. Tillson, in the valuable chapter on "The Theory of Pavements" in his book on "Street Pavements and Paving Materials," appears to have originated the method of selection by assigning comparative values to the different qualities of surfaces upon a scale of 100, as follows:—

	Values.
Cheapness	14
Durability	21
Ease of cleaning	15
Light resistance to traffic	15
Non-slipperiness	7
Ease of maintenance	10
Favorableness to travel	5
Sanitariness	13

Mr. Tillson also gives, in his table number 51, a summary of the values of the various qualities which he assigns to different pavements, as compared with the full value in the ideal pavement. By combining the various values of the properties which are demanded to meet particular conditions this author shows how the selection of a pavement may be made. In speaking of the values as applied to various pavements, Mr. Tillson says: "It must be understood, of course, that the table is a general one; that much of it is based on the personal judgment of the author; and it will vary in different localities, even if the conclusions are agreed to."

Mr. Ira O. Baker in "Roads and Pavements," divides the qualities of pavements, and gives the relative values as follows, in percentages of the value of an ideal pavement:

	Values.	
Economic Qualities:		
Low first cost	15	
Low cost of maintenance	20	
Ease of traction	10	
Good foothold	5	
Ease of cleaning	10	—60
Sanitary Qualities:		
Noiselessness	15	
Healthfulness	10	—25
Acceptability:		
Freedom from dust and mud	10	
Comfortable to use	3	
Non-absorbent of heat	2	—15

Mr. Baker states: "The assignment of these numbers is wholly a matter of judgment, and different individuals will differ greatly as to the relative values to be

*Paper presented at the Tenth Annual Convention of the American Road Builders' Association, Philadelphia, Dec. 9-12, 1913.

given to each quality. Different values should be assigned to the same quality according to the attendant conditions. The application of these principles is likely to be complicated by the personal interests of the residents or property holders."

An indication of the values of the qualities of different pavements is obtained from the average of the values as signed in ten replies by that number of paving engineers to an inquiry by the United States Forestry Service, which are tabulated as follows, using standard values which are apparently based on Mr. Tillson's but differ slightly, viz:—

sidered. A certain tonnage in heavy slow-moving vehicles with iron tires produces an entirely different effect from that produced by the same tonnage in lighter rapid-moving automobiles with rubber tires; and a still different effect will be produced by the same tonnage in heavier and slower motor trucks. It has been well suggested that a traffic unit should be adopted, which could be used to represent, as far as possible in the same denomination, the amount of wear caused by the passage of one ton over the road in each of the several ways. The width of space available for travelled way must be considered in connection with the amount of traffic.

Comparative Value of Different Pavements.

Qualities.	Standard percentage value.	Granite.	Sand stone.	Sheet asphalt.	Asphalt block.	Brick.	Macadam.	Treated wood block.
Cheapness	14	4.0	4.0	6.5	6.5	7.0	14.0	4.5
Durability	20	20.0	17.5	10.0	14.0	12.5	6.0	14.0
Ease of maintenance	10	9.5	10.0	7.5	8.0	8.5	4.5	9.5
Ease of cleaning	14	10.0	11.0	14.0	14.0	12.5	6.0	14.0
Low traction resistance	14	8.5	9.5	14.0	13.5	12.5	8.0	14.0
Non-slipperiness	7	5.5	7.0	3.5	4.5	5.5	6.5	4.0
Favorableness to travel	4	2.5	3.5	4.0	3.5	3.0	3.0	3.5
*Acceptability	4	2.0	2.5	3.5	3.5	2.5	2.5	4.0
Sanitary quality	13	9.0	8.5	13.0	12.0	10.5	4.5	12.5
	100	71.0	73.5	76.0	79.5	74.5	55.0	80.0

*Acceptability includes noise, reflection of light, radiation of heat and emission of odors, etc.

The prime factors which should determine the selection of a type of surface, when this selection is not limited by any necessity for giving undue preference to any factor, appears to be as follows:—

1. The volume and nature of the probable traffic over the pavement.

2. Conditions incident to the location of the pavement; including the character of the adjacent land and improvements; the character of the foundation; the kinds of adjoining pavements; the ruling gradients; the climatic conditions; and especially the availability and cost of different materials at the work.

3. The characteristics of the surface which will adequately meet physically, hygenically and esthetically the conditions expressed in the two factors first named. These characteristics are practically those named in the tables cited.

4. The quotient obtained by dividing the total estimated traffic to be carried per unit of width into the cost per unit of area of the pavement during its probable life; including first cost and interest on the same; special surface treatment for dust suppression or other purposes; and any necessary repair until replacement; but not including the cost of cleaning. For the best pavement this quotient will be the lowest. This ratio may be called the ultimate cost of the pavement per traffic unit carried.

(1) The volume and nature of the traffic—not the present traffic, if the road now exists, but the traffic after the improvement—is the most essential factor. This must necessarily be approximated, and due allowance should be made for increase during the life of the pavement. The effect of traffic upon the pavement should be expressed in units of a known value, to which all classes of traffic can be reduced.

The different effects produced on a surface by different kinds of traffic are elements which must be considered. Traffic when confined to a single vehicle width is very damaging and widening a few feet only may easily double or triple the life of a pavement.

One solution of the character of the roadway, when pleasure traffic and commercial vehicles use the same highway, is to construct a surface adapted to each, separated by a short distance, making a double roadway. This is done to the great advantage of the road users of every class where the travel is sufficiently dense to require it. It is customary, for the reasons indicated, as well as from and esthetic standpoint, to prohibit heavy traffic on roads built especially for pleasure drives. This factor of traffic, which is one of the most essential, is sometimes given the least consideration, and we occasionally hear of a county or township bonding itself for a costly form of surface where a gravel road would answer the probable demands for some time. On the other hand, in the neighborhood of cities, where the travel is already heavy and sure to increase, roads or pavements are frequently laid which are inadequate for even present conditions.

The nature of the future traffic is quite as important as its volume; although owing to rapid changes in the weight and speed of freight-carrying trucks, and the increase of motor-driven vehicles, this is difficult to forsee. An estimate of traffic on a city street made for thirty years hence would probably almost ignore horse-drawn vehicles, and would provide for the heaviest class of motor-trucks instead. If the traffic is to be of one class only, such as motor vehicles driven for pleasure with a moderate limit of speed, the problem is much simplified, and it is the writer's experience that no class of traffic is more easily or cheaply provided for. If there is to be a mixed traffic of horse-drawn vehicles, motor trucks, and other automobiles, with a possibility of the steam-lorry and train of wagons in the future, this combination will require a very strong and durable pavement, and first cost should be given little consideration.

There is an approximate limit to the amount of tonnage which can pass over any width-unit of pavement in a given length of time; and any amount of traffic approaching this would demand the very highest type of surface practicable to be constructed. This limit is probably seldom reached for more than a few hours daily on the heaviest travelled streets.

(2) The nature of the surrounding conditions is a potent factor in determining the character of the surface. In a manufacturing or wholesale district where noiselessness is less essential a granite or brick block may well be used on account of its strength or durability; whereas in a residential section the less durable but more quiet asphalt or wood block is better. In a farming or country area, a macadam or gravel road harmonizes more perfectly with the surrounding fields and woods.

The value of the adjacent property has a large bearing in the case, for it is the basis of the revenue which usually must be raised to pay for the improvements. A closely built city block can fortunately afford a much higher priced pavement than a less closely built suburban section, on account of its larger taxable value.

The character of the foundation governs the construction in many cases. An especially soft sub-grade may require a base of cement concrete; while, with certain types of pavement, upon hard ground, this might be omitted at a considerable saving of cost. If the problem be that of surfacing an old waterbound macadam roadway, it may be solved by using a surface, for instance, of bituminous concrete, placed directly upon the old macadam; whereas, if no such foundation existed, an entirely different type of pavement might be required. A rigid surface, such as one of cement, should never be placed where there is danger of settlement.

The ruling gradients of the road must be considered, for the reason that some pavements do not afford sufficient foothold upon steep grades, and the climate must be taken into account, since pavements are differently adapted to warm or cold or wet or dry conditions. The character of adjoining pavements will have weight with the engineer, except in cases where the requirements are very exacting. Again, the practical consideration as to the availability of contractors and suitable construction plants in the vicinity must have weight as entering into the price to be paid.

Among local conditions, the availability of material, either local or foreign, the use of which latter largely depends upon the cost of transportation, is probably the deciding factor in more cases than any other. A city in an area producing excellent paving brick would be unwise to import granite block from a distance at a heavy cost for freight; or even to pay too heavily for the transportation of asphalt, and a western country could by no means afford to pay the cost of transporting the trap-rock used so largely on roads in the east, but must find the solution of its problem in the use of a surface of cement concrete or other material produced nearby. The very possibility of the construction of any roadway whatever, in many cases where the funds are limited, is dependent upon making the best possible use of the local materials available.

(3) The characteristics of the surface to be constructed, which must satisfy the requirements of the traffic, the environment, the foundation, the gradients, and the climate, may be divided into three classes, viz.:

(a) Those which are purely physical;

(b) Those which are required for health;

(c) Those meeting requirements of a more or less esthetic nature.

(a) The physical requirements are those previously stated, viz.: Strength; durability; ease of traction; sufficient roughness when either dry or wet to prevent slipperiness; imperviousness to a greater or less degree; sufficient smoothness to render the surface easily cleaned and to prevent excessive jarring of vehicles passing over it at high speed, and facility of repair, both as to openings and as to wear of the surface.

(b) The requirements as to health include noiselessness, freedom from dust produced by the wear of the wear of the pavement, and heat-absorbing and heat-radiating quality in a minimum amount.

(c) The esthetic requirements are such as appeal more directly to the senses. These are harmony with surroundings, a pleasing appearance, extreme noiselessness, and almost absolute smoothness. These qualities in their highest degree are usually demanded only in connection with streets of the highest class, or with pleasure drives.

Examining these characteristics further, but without going into details as to the qualities of materials, we find as follows:

Imperviousness is a very important feature, both from a sanitary standpoint, and as a matter of increasing the durability. No very permeable surface can be considered a good one.

Smoothness is particularly demanded by motor-vehicles, especially where speed can be used. Non-slipperiness is produced by slight irregularities in the surface. It is necessary for good foothold and to prevent skidding of rubber tires when the surface is wet.

Facility of repair is essential; and for this reason the pavement should not be constructed of materials and by methods which will be difficult to duplicate after the completion of the original pavement, without at least providing for its repair. Block pavements lend themselves most easily to repair, since they require no large plant for that purpose.

The sanitary requirements are mostly for the benefit of the public living or working on the streets, and less for the road-user. A noisy pavement with much travel seriously affects the nerves of those near it; a dusty pavement permits fine grit to be carried into eyes and lungs and becomes a muddy pavement in wet weather. A heat-absorbing and heat-radiating pavement, such as sheet asphalt, if exposed to the sun, adds much to the temperature of the street and the surroundings in the hot weather, to the discomfort of all in its vicinity.

The esthetic requirements are such as add a touch of good taste, and perhaps of luxury, to the road and are increasingly in demand.

All of these requirements will have somewhat different weights in different cases. Some of them can be omitted in considering nearly every case, and must be omitted often. In view of this it seems best not to assign special values to these requirements; but in each case to give preference to such characteristics as the situation demands, and to use the surface combining these characteristics in the greatest degree.

(4) This combination must produce a pavement, usually, which will give the lowest ratio of total cost to the total traffic units to be carried. The surface thus chosen should be that which is best adapted to the purpose.

In instances in which a high first cost might be prohibitive, the pavement showing the lowest cost-tonnage ratio could not always be selected; and a less costly surface with a higher rate of maintenance would be necessary.

The process of selection will usually be one of elimination, thus for a certain case of proposed construction several well-known classes of pavements, of nearly equal theoretical value, will be considered; say, granite block, vitrified brick, wood block, and sheet asphalt. If low cost is paramount, this element may eliminate the granite block and the wood block; and if noiselessness is desired, the vitrified brick will be eliminated; leaving the sheet asphalt, or a similar surface, to be adopted. If durability alone is considered, the granite block might be chosen where this material is convenient; whereas, if the case demanded noiselessness, smoothness and durability in a high degree, without especial reference to first cost, the wood block would probably receive the verdict.

A resident paving-engineer familiar with the local conditions and with pavements in general often need not tabulate or even assemble, otherwise than mentally, the reasons for his choice, and this mental way is very often the method of selection employed. In such cases, however, the same conditions should, and do, actually control as would be the case if the situation were being considered for the first time with the utmost pains.

In order to proceed with system in the matter of choice of a new pavement, or one in a new location, the engineer should have the necessary data as to traffic; as to cost of construction and maintenance of similar pavements in the vicinity, or under like conditions; as to the life of such pavements; as to climatic conditions, and, in fact, all available information on the subject. It is unfortunate that the supply of information on the subjects is not what it should be. This is a defect which every highway engineer can aid in correcting, by careful investigation and records in connection with his work. In the absence of the necessary data, the selection is merely an assumption based on judgment and experience, and sometimes on a desire to experiment, and this is the manner in which the choice is very often made.

On the whole, the selection of a pavement, like the tariff, is largely a local question, and in its final aspect, when under practical consideration, presents such a number of features, some of which are predominant at one time and some at another, that each case must usually be considered alone.

The matter is well summed up in this quotation from Mr. Tillson: "The official who decides on the material after the most careful investigation will often find that his decision is displeasing to many people. . . . . He must make his decision after taking all things into consideration, and stand by it although it will not always prove satisfactory to all. . . . . But if he meet the question successfully, and ultimately arrive at the true solution, his satisfaction is as great, perhaps, as in any other branch of his profession."

The reason why oil paint will not stand well on concrete surfaces is that the oil is saponified by the free lime of the cement. It is stated in a French architectural journal that this drawback can be obviated by first applying a wash of zinc sulphate in the form of a 1 : 5 solution, the result being to produce a film of plaster and zinc oxide which is quite harmless to oil.

THE SELECTION OF A ROAD SURFACE.

Discussion by W. A. McLean, Commissioner of Highways for Ontario.

THE paper by Mr. Grabill on "Factors Governing the Selection of a Road Surface or Pavement" is a most interesting and illuminating contribution. It expresses the complexity of the modern problem, which at times confronts road authorities.

Traffic.—Whatever other factor may enter into the problem, roads should be built to suit the traffic, using available materials to the best advantage. To do this, requires a thorough knowledge of (1) the traffic, and (2) the material. A paper read before this association last year by Col. Schier, of Massachusetts on "Traffic Census" is one of the most noteworthy statements on this phase of the subject yet produced, and is a type of analysis of which we have great need.

Knowledge of Material.—Traffic on the public highway within the past decade has so radically changed, that our knowledge of the characteristics of materials in meeting the new requirements is proportionately limited. A paving material should be in general use for at least its estimated lifetime before the facts regarding it are, to a reasonable extent, at our disposal. The mass of facts which we possess regarding any proposed material is an important factor in selection.

The elementary materials actually in use in road-building are comparatively few—such as broken stone, gravel, sand, clay, asphalt, tar, oils, vitrified brick, creosoted wood, stone setts, Portland cement—but their combinations and variations are almost innumerable. Unless some entirely new material comes above the horizon, the next five years will be a striking era, in leading to the more effective use of the materials now available, in confirming or setting aside our opinions of to-day and in standardizing construction. So far as roads of the open country are concerned, of which I am more especially speaking, there is a vast amount of theory still to be tested.

Division.—A road or pavement may be conveniently divided, for consideration, into four parts: (1) The system of drainage; (2) the earth sub-grade; (3) the foundation, and (4) the wearing surface.

As a rule, the wearing surface necessary will dictate the character of the substructure. But in other cases, one or more necessary or existing features of the substructure will influence our choice of wearing surface.

Foundations.—A secure foundation is an absolute necessity for permanent bituminous coatings. To this end a substantial depth of foundation should be used, a condition with which roads on this continent have not always complied. Very few conditions of heavy or constant traffic can be successfully met with a less foundation than 6 to 9 inches, or a less total depth of stone in the road crust than 10 to 12 inches. The price of good roads in one particular, at least, is a substantial depth of stone. The difficult part of our problem, the financial aspect, is not so much the selection of a wearing surface as our ability to pay for strong foundations. The existing foundation, or local materials available for a foundation will frequently dictate what the surface should be.

Heavy motor trucks and busses are placing a great and unexpected strain on road foundations. On main roads leading out of London, England, old 6-inch concrete foundations are being torn up and 9-inch foundations

put in their place. This is necessitated by heavy and constant motor-bus and traction engine traffic.

New Bituminous Coatings.—In Great Britain, France and other countries of Europe, bituminous treatment has largely become the accepted practice in meeting the requirements of motor traffic in the open country: By carpet coats; by grouting or penetration; and by mixing methods, according to local conditions. It need not be said that asphalt and tar are now, on this continent, being used with marked success—a result that has been reached after many trials and not without tribulation.

That bituminous paving has been markedly successful in England is probably due, to a large extent, to the fact that it has been commonly applied only on old, solid and well-settled foundations, in re-surfacing their old macadam roads. Many of the failures on this continent, on the other hand, have plainly been due to weak, badly-drained foundations. To uneven settlement of new roads under traffic may be attributed much of the failure of bituminous surfaces, rather than to any inherent defect in bitumen itself for road purposes.

Settlement of New Roads.—Roads, as we now build them, are rolled in several layers with a ten- or twelve-ton roller, giving a compression of 500 lbs. per inch. Traffic follows with tire compression up to 700 and 800 lbs. per square inch. Under succeeding wet conditions of fall and spring, settlement must inevitably occur, leading to an uneven, wavy surface and consequent decay.

In the speaker's experience, a broken-stone road, commonly does not reach final settlement for two or three years after first construction; but within that period permanent subsidence may be taken for granted. French, German, and English road-builders laying bituminous surfaces over their old roadbeds, are manifestly not dealing with a condition which commonly exists here.

A reasonable course to pursue in many cases would be to build waterbound macadam roads on Telford or other suitable foundation. The surface could be maintained for two or three years by thin paint coats or oiling. At the end of that period perfect settlement and stability of the foundation having been attained, a heavy and durable bituminous surface could be applied where traffic demands it.

Concrete Roads.—The prejudice against concrete roads has within the past couple of years, been largely broken down, and a good deal has been done to demonstrate their value when built under favorable conditions; indicating more especially a one-course mixture; a high proportion of cement; a clean, tough aggregate; a flat undersurface; joint protection, and good drainage. A number of experimental sections have been built by the Ontario Highway Office, under varying conditions.

So much may be hoped, that there is a temptation to prophesy, but adhering to a strict basis of proven fact, and in the light of our knowledge of concrete in other structures, it is conservative to say that the next few years should be fruitful in determining the place of this important material, in the field of roadmaking; in putting the facts at our disposal to determine when and how it can be used with economy and certainty of results.

HIGHWAY IMPROVEMENT IN SASKATCHEWAN.

THAT the good roads movement is taking as firm hold in the west as in the east is evidenced by the very progressive manner in which their improvement has been undertaken by the various provincial governments of the western provinces.

The first annual report of the Board of Highway Commissioners of Saskatchewan for the year ending Feb. 28th, 1913, shows a very creditable advance in that province. The board derives its power from the Provincial Act respecting the construction and improvement of public highways, March 15th, 1912, and consists of three members appointed by the Lieutenant-Governor-in-Council, together with an advisory committee of two to be called upon when required by the chairman of the board.

Immediately following the passing of the Act, an appropriation of $1,500,000 was made by the assembly, and this amount, together with $100,000 with which the Public Works Department were to have carried on the erection and repairs of steel bridges was placed at the disposal of the Board of Highway Commissioners. This made a total of $1,600,000 available for roads and bridges, $1,300,000 of which it was decided to spend on the former.

Three main points, according to the report, were kept constantly in mind in determining the distribution over

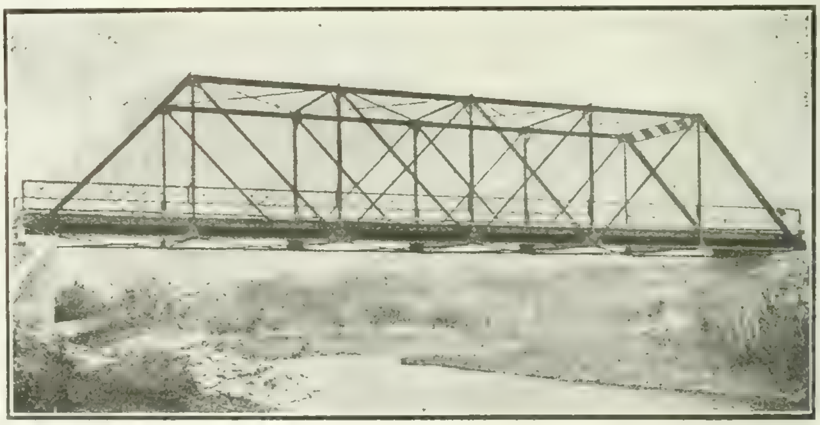

Fig. 1.—A 100-foot Steel Span on Concrete Abutments Over Eagle Creek, Sask.; Typical of the Steel Highway Bridges of the Province.

the province. First, a schedule was prepared whereby each municipality could receive $5,000, or each constituency $30,000. Then, main or trunk roads having the heaviest traffic, and feeding large areas were to have preference. Lastly, assistance would have to be given to many places in the province "where improvements were urgently required, which, although not on roads classed as main roads, were so far beyond the means of the local authorities" that government assistance would be imperative. This last applies to bridges and long side-hill roads across ravines and valleys, fills across large sloughs, marshes, etc. It was necessary, of course, to deviate considerably from the rule of only giving $5,000 to a municipality, but this rule was kept in view, and by it a fairly equitable distribution was obtained.

To thoroughly familiarize themselves with existing conditions, and to decide where improvements were most necessary, the board enlisted the help of inspectors, muni-

cipal councillors, and others; and thus succeeded in obtaining a great quantity of information by which they were enabled to start working out a main road system for each municipality in conjunction with adjoining systems. An effort was made to induce each municipal council to decide on what should be the main road system within their boundary, and in this they were assisted in every way possible by the board.

To hasten the commencement of the work so that the assembly's programme might be carried out in 1912,

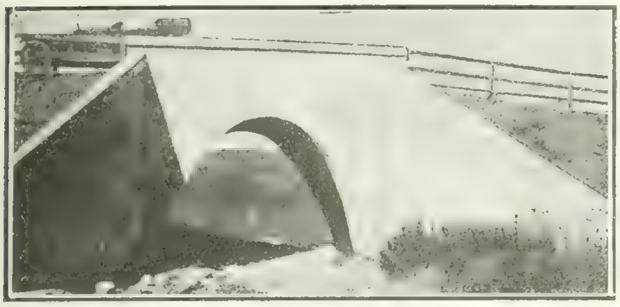

Fig. 2.—A 20-foot Concrete Span Over Gibson Creek, Sask.

a bulletin giving the board's aims, together with various methods of road construction, was widely disseminated throughout the province. To induce the municipalities to co-operate a set of regulations was adopted whereby each municipality could be assisted each year to the extent of 50 per cent. of the cost of any improvement they wished to make, subject to the restrictions in the regulations, some of which are noted below.

The assistance in any case is not to be more than the amount previously mentioned ($5,000). This applies to road construction, and not bridges. The improvements must be of a permanent nature, and such as may suitably be paid from capital account, and the construction must in every way be satisfactory to the board. A rather interesting clause is to the effect that the board have power to valuate any work, in their opinion costing too much,

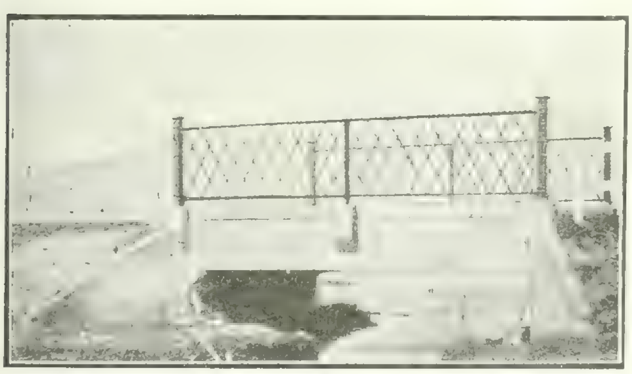

Fig. 3.—A 20-foot Concrete Span Over Rosthern Creek, Sask.

and pay the grant accordingly. To induce the local authorities to properly care for the roads when constructed their condition will be considered in giving further assistance.

Besides the distribution of bulletins of useful information on road making and actual help in construction, experiments have been made with the idea of overcoming special difficulties. So far nothing very definite has resulted from them, but they have served to indicate lines along which success may be possible, and it is probable that before long some method may be devised whereby the unfitness for earth road making of many of the gumbo clays throughout the province may be overcome.

By addition of the tabulated lists in all 363 roads were worked upon by government road gangs during the year, and 145 rural and urban municipalities received government assistance outside the regulations of the Board of Highway Commissioners. The amount expended directly on road improvements was $1,025,958.66. By direct grants to municipalities $100,935.54. By municipalities under the regulations, $138,325.87. Bridges departmental staff, inspection, printing, etc., cared for the balance of the appropriation.

Bridge Work.—The following summary of the bridge work is of interest. In all 19 steel and 2 concrete spans were constructed as follows:—

Construction.	Number of spans.	Length of span.
Steel	1	250 feet
Steel	2	150 feet
Steel	3	126 feet
Steel	4	100 feet
Steel	5	80 feet
Steel	3	60 feet
Steel	1	40 feet
Concrete	2	20 feet

The 250-foot span is over Battle River west of Battleford, and is a Pratt truss with curved top chord. The steel was supplied by the Canadian Bridge Company, of Walkerville, and erected by R. J. Lecky Company, of Regina, who erected the steel on twelve of the nineteen spans mentioned above. The departmental crews erected the steel for five, and Mr. E. Lenkin, contractor, the sixth. (There is one steel bridge to be erected.) The Hamilton Bridge Company supplied the superstructure for nine, the Western Steel and Supply Company for five, the Sarnia Bridge Company for four, and Wm. McNeil and Sons, Nova Scotia, for one of the 126-foot spans. The two 20-foot concrete spans were erected by

Fig. 4.—Typical Side Hill Grading, Saskatchewan.

J. J. McDonough, who also was the contractor for the abutments of two steel spans.

If the Saskatchewan board continues as it has begun a great future may be predicted for roads in that province, and if, as the chairman, Mr. A. J. McPherson, anticipates, it will be able to co-operate with the other provinces in a coast-to-coast highway and also highways to other points of importance in Canada, a great boon will not only be conferred on each province but the country as a whole.

WATER POWERS IN MANITOBA

IN January 1st issue of *The Canadian Engineer* a reference was made editorially to a report submitted recently by Hon. W. J. Roche, Minister of the Interior, to the Public Utilities Commission of Manitoba, respecting the physical features of the water powers within the province. The engineers of the Water Power Branch, under the direction of Mr. J. B. Challies, Superintendent, have been making a systematic study of water power and stream flow throughout Manitoba. The report shows, in result, the power possibilities of the various rivers. The following information is derived from Mr. Challies' letter of transmittal to Judge H. A. Robson, Chairman of the Commission.

As stated last week, the main sources of dependable power in commercial quantities are the Winnipeg River, the Grand Rapids on the Saskatchewan River, the Churchill, Nelson, Berens, and others of the larger rivers of the north.

The first of these, the Winnipeg River, with its tributary, the English River, lies within easy transmission distance of the present commercial centres of the province. It can furnish an adequate supply of hydro-electric power to satisfy all anticipated power requirements of the present settled communities.

Such a statement as this possesses a degree of attractiveness that will readily be embraced by the various power-using industries of the province. The development of an adequate supply of dependable water power, in the face of an alarming and constantly increasing price of coal for steam production, combined with the scientific progress that has been made in the manufacture of power generators, transmission apparatus, and equipment for economical consumption of electricity, unite to endorse unhesitatingly authoritative steps to increase the industries at present in operation or under contemplation. To this should be added the demand for hydro-electric energy for transportation and municipal enterprises, such as are springing up in and around the city of Winnipeg, and which have made the question of power development on the Winnipeg River one of the most important administrative matters that is occupying the attention of the Department of the Interior. Fortunately a well-considered and cautious policy of water power administration has been determined upon, and regulations put into force which afford every reasonable protection to the public in the way of limited grants, rentals and control of rates, both subject to periodic revision, and at the same time providing sufficiently attractive opportunities for investment to actively interest the capitalist.

Consistent with the policy of the Dominion Government, the Minister of the Interior has instructed that all vacant Dominion land contiguous to power sites on the Winnipeg River, or any other river in Manitoba, be reserved for disposition only under the water power regulations referred to.

It was early found necessary, in connection with the consideration of sundry applications for power privileges on the Winnipeg River in Manitoba, for the Water Power Branch to have extensive power and storage studies made of that portion of the Winnipeg River within the province of Manitoba. These investigations show that at eight distinct power sites, by means of storage easily and cheaply accomplished at the Lake of the Woods, at Lac Seul and at other lakes in the province of Ontario, it is possible and economically feasible to develop over 409,700 continuous 24-hour horse-power all within 80 miles of the city of Winnipeg and within feasible transmission distance of all commercial centres of the present settled portions of the province.

Of the eight possible power sites on the Winnipeg River there are three now under development, representing a total power capacity of 199,000 24-hour horse-power. One site is completely developed by the Winnipeg Electric Railway Company on the Pinawa Channel, and produces about 26,500 h.p. under most favorable conditions. Another site at Point du Bois Falls, developed by the city of Winnipeg, produces at the present time about 20,800 h.p., but is capable of extensions to a maximum of 77,000 24-hour horse-power. Development at the third power site at Great Falls, having a maximum possible development of 95,500 24-hour horse-power, is about to be commenced.

There is, therefore, at the present time about 47,300 h.p. produced on the Winnipeg River, and transmitted for use in and around the city of Winnipeg, which can with the two present plants be increased to 103,500 24-hour horse-power.

The five remaining power sites on the Winnipeg River are under the control of the Dominion Government, and can furnish a further amount of 24-hour power to a maximum extent of 210,700 h.p. In addition there are several important power sites on the Winnipeg and English rivers within the province of Ontario, which are within easy transmission distance of Winnipeg.

It is interesting to note that the Winnipeg River in its natural condition forms one of the most notable power rivers in the world, having a total drop in the province of Manitoba of 271 feet, and in average years its maximum flowage being only about four times its minimum—about 12,000 c.f.s. Full information regarding the enormous potential power resources of the river is set out in detail in the report by Mr. J. T. Johnston, Hydraulic Engineer of the Water Power Branch, under whose direction the surveys and investigations of the branch have been carried on.

With respect to the rivers in the far North, it is stated that the power possibilities associated with them will be of great importance to the future development of this portion of the province, although little is known of them at the present time, the only available data being from reconnaisance surveys. However, the data is sufficiently reliable to indicate that enormous amounts of dependable power, capable of economical development, are there.

With the exception of the information in the report relating to the Winnipeg River the preparation of the material was commenced by Mr. Douglas L. McLean, then chief engineer of the Manitoba Hydrographic and Power Surveys. Since his resignation in October, the work has been carried on by Mr. S. S. Scovil, assistant engineer, to whose energy and resourcefulness Mr. Challies, in his letter, pays tribute for the compilation of the material in the short time available.

The Fort William plant of the Canadian Car and Foundry Company will be in readiness to operate about May 1st. As to whether it will be started up immediately upon the completion depends, of course, upon the abundance of orders for cars, but it is altogether likely that the plant will not delay in getting into operation.

WOODEN STRUCTURES.

By J. A. Macdonald, Ottawa, Ont.

In a great forest country like Canada, wood, as a material for the construction of viaducts, bridges, trestles, etc., can frequently be selected in preference to stone, cement or steel, on the score of economy; and also owing to the comparative rapidity with which such structures may be erected. Wood is, of course, very inferior to these other materials as regards strength and durability, and in construction work the inherent defects of wood must be counteracted as fully as possible. Experience has shown that the most simple combinations of timber are superior for strength to complicated systems, and the latter have become almost entirely abandoned. By calculation, a scientifically framed truss may be made, but the impracticability of making such a perfect assemblage of the timbers as the calculations would have been based upon, renders such complicated combinations unwise. Moreover, to obtain even that degree of perfection of which practice is capable, we must resort to an excess of strapping, bolting, keying, mortising, and jointing of every description, which becomes very expensive, and when we have done all this, the destructive effects of rain, sun and wind increase in the very proportion of complication embodied in the system of construction. Besides, also, an unavoidable quantity of moisture is wasted, which might have properly been reserved for an increase of strength under a more simple mode of treatment. The intention of a truss, composed of a multitude of timbers, is not only an equable distribution of the superimposed weight, but also a dispersion of the shaking and vibration resultant from the motion of weight. Nothing but the very best workmanship must obtain, and we all know how extremely difficult this may be, however great the expense incurred.

The Mortise and Tenon.—A few words on details may be of some service to the reader. Timbers are connected by various types of joints, the most simple being generally the best. Fig. 1 shows a tenon and mortise. The thickness of the tenon, *T*, is made, according to the best engineering authorities, one-third the thickness of the timber on which it is cut, and the size of the mortise, *M*, corresponds to the dimensions of the tenon. The depth of a mortise should exceed that of the tenon by a small amount for a more perfect joint. The shoulders of the tenon should be exactly in line, and perpendicular to the axis of the timber. When acting by suspension, little depth is required if a strap be added; an oak treenail should be driven through the timbers, the holes being bored after the tenon is in the mortise. The diameter of the treenail should be, according to Colonel Emy, "one-quarter the thickness of the tenon, and the hole bored for its reception should be two-thirds from the end of the tenon," as shown in the figure; but the value as regards the strength of a tenon and mortise should be independent of the treenail. This is for a rectangular mortise and tenon. Fig. 2 shows an oblique joint of this description, and is self-explanatory. The above description of joint, though common, is not the best kind, the timber, T, being weak at the point, *a*, and liable to fly. Fig. 3 is a better system, where *T* is partly joggled into *M*, and *s x* is made of from about one-fifth to one-fourth of the thickness of *M*.

In setting out a joint of this kind, with a single joggle and no tenon and mortise, to find the direction of *s x* (Fig. 4) draw the central axis of the timbers, and *o s* will give the direction of *s x*. Or, divide the angle *a s b*, and the line *s v* will give the direction *s x*. Another method is to make *s x* perpendicular to *s b*; and another, from *c* as a centre with a radius *c s*, describe an arc, on which set off from one-fourth to one-fifth of the thickness of the timber *M*. It must not be forgotten that too sharp an angle at *x* is likely to make *M* fly at *x*.

Scarfing.—It is always expensive to obtain timbers of large scantlings and great length, and when a beam of 24 feet or more is required, we have generally recourse to scarfing which, it is unnecessary to add, is a joint in which the ends of the timbers are cut and overlapped so as to present a uniform appearance. Some are partial to complicated scarves, but there should be no greater faith in them than in complicated trusses, much for similar reasons, and because so much hacking of the timbers must weaken it. Moreover, they become very expensive.

In a scarf it is evident that the bearing surfaces have to support the strain, and therefore the greater the quantity of surface the greater the strength, provided the best form be given. Therefore, a long scarf is stronger than a short one, for the same reason that any strength at all is gained by a scarf, but a great waste of timber and much workmanship involved. One important consideration, and which should never be lost sight of, is the strain to which a scarf will be exposed, compression or tension.

Fig. 1.

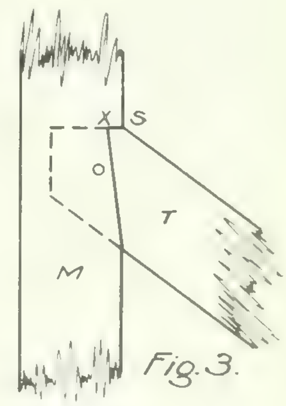

Fig. 3.

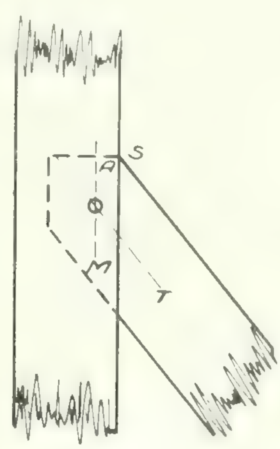

Fig. 2.

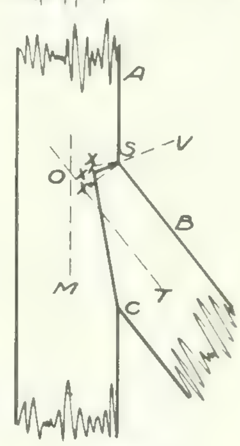

Fig. 4.

Scarves are greatly strengthened by iron bolts and oak keys. Where the surfaces of the scarfing are square, iron bolts are preferable to keys. The contrary is true where the jointing surfaces are oblique to the fibres of the wood. Let Fig. 5 represent a beam scarfed at *W*, where it is exposed to a strain from the weight at *W*. The

upper portion of the beam is exposed to compression. The rectangular bearing, a, is therefore the most appropriate, as an acute angle formed by a line parallel to b, would, on the beam being compressed, act like a wedge, and tend to make the upper portion of one beam fly. But this is reversed at b, which point would tend to open by tension. Of the keys, c and d, the first would be under compression, and the latter would be loosened. Being near the neutral line, the tightening and loosening would be comparatively small, unless the beam were loaded beyond its safe bearing strength. Also c, under compression, would tighten the beam *a*, and though *d* would not do the same at *b*, the bevel joint must prevent any evil results. Whether we have one, two or more keys, the single or aggregate depth should not exceed the depth of the beam. Neither should they be too violently tightened when driven. This scarf is short and considerable strength may be added by a bolt at *W*. It would be better still to place a bolt at *c* and at *d*, with the key in the centre, as in Fig. 6.

Fig. 7 is strong enough for most purposes. It need scarcely be observed that the further the scarf may be

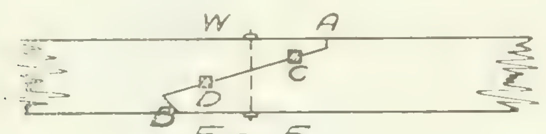

Fig 5

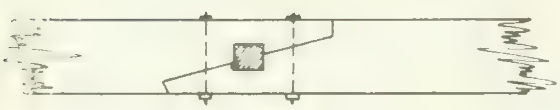

Fig 6

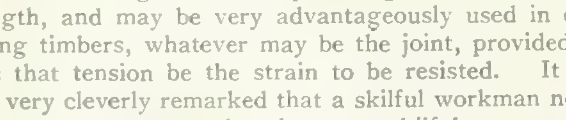

Fig 7

from the points of bearing, the greater the strength required. Bolts should never be placed too near the end of a beam. Wrought iron straps are great auxiliaries of strength, and may be very advantageously used in connecting timbers, whatever may be the joint, provided always that tension be the strain to be resisted. It has been very cleverly remarked that a skilful workman never employs many straps, but however skilful a carpenter may be, he cannot prevent the effects of atmospheric influence; neither can he give to comparatively new wood the properties of well-seasoned timbers. No man who knows anything about designing in wood, would consider straps as factors of strength in his construction work, but simply as fastenings and auxiliaries. They are perfectly admissible, of course, in moderation, and are becoming daily more in use. Before use, straps, and indeed all iron work, should be heated to a blue heat, and struck over with raw linseed oil. This is much preferable to paint as preventative from rust. A strap 1 inch wide may be made ¼ inch thick; 1½ inches wide, ⅜ inch thick; 2 inches wide, 7/16 inch thick.

Cast iron plates and shoes are also very useful to receive or to equalize the thrust from the ends of butting timbers; the first particularly where employed as a connecting surface between the ends of timbers, which from shrinkage, defect of workmanship, or otherwise, may come to bear upon opposite angles, instead of the whole area of their intended connected surfaces.

Wooden Piers.—As regards piers, too much depends on circumstances connected with the nature of the natural foundation to recommend any particular plan. According to these circumstances, it may be advisable to build entirely of wood or of masonry and wood. It must not be forgotten that wood exposed alternately to wet and dry cannot last long, and this, therefore, is one reason for employing stone or concrete in water or marshy ground. On the other hand, in weak ground wooden piers are preferable, and sometimes it may be advisable to make a wooden pier occupy an area of considerable extent, in order to spread the effect of a superincumbent weight over a greater surface; and thereby, to a certain degree, neutralize this effect. Such may be the case in working over ground that is peaty to any considerable depth.

To Ascertain the Cohesive Strength of Timber.—The tension that timber will bear, when the force acts in the direction of the axis of the timber may be calculated by multiplying the area in inches by the proper "tabular number" from a table of specific gravities. For example, to find the force that will tear asunder a piece of 4-in. by 4-in. fir, we have an area of 16 square inches, and the tabular number is given as 9500; thus $9500 \times 16 = 152,000$ lbs., one-fourth of which would be taken in practice for a perfectly safe load.

Given the load, the size of the scantling may be calculated by reversing the method.

Not long since the River Euphrates was diverted from its new course at Hindlieh, where the firm of Sir John Jackson (Limited) have recently completed the first great barrage in connection with their extensive Tigris-Euphrates irrigaton works. This is a part of Sir William Willcock's scheme upon which the Turkish Government originally proposed to expend some twenty millions sterling. The whole operation of turning the river into its new course passed off most successfully. The river was diverted by a dam, held up by a barrage, by means of which the water can be distributed through a regulator down the old Hilla branch past Babylon to ancient Hilla. The barrage was built to the east of the river bed. It is 800 feet long, and consists of thirty-five arches fitted with sluice-gates, each sixteen feet wide. The piers are nineteen feet high and four feet thick and the key-piers eleven feet. They rest upon a foundation of three feet of concrete and six feet of brickwork. The barrage will raise the level of the water twenty-two feet. Another barrage has been built immediately below the upper Hindlieh barrier. This was a perfectly straightforward bit of work, consisting of a lock and a huge shelf of masonry. By these means a dam of 130 feet thick has been flung across the river, which is 520 feet wide at this point, and the water turned into the new bed. When all these works at Habbania and Hindlieh are complete, with the smaller irrigation canals, some 600,000 acres of land will receive a plentiful and constant supply of water; and the ancient problem of the Babylonians will have been solved by British engineers.

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CONTENTS OF THIS ISSUE.

WATER MUNICIPALITIES IN BRITISH COLUMBIA.

Legislation is being planned in British Columbia for the establishment of municipal organizations to control the conservation and distribution of water for irrigation purposes. If the bill which will shortly come before the provincial legislature becomes law, farmers in the dry belts will be in a position to co-operate in the operation of irrigation systems. It will make possible the joint ownership and control of irrigation enterprises in any locality where the lands are so situated that they can be irrigated from a common source and through a common system. Such a bill will affect considerably the Okanagan, Kamloops, Southeastern Kootenay, and Ashcroft districts.

This bill for the formation of water municipalities is the logical sequence of the revision and consolidation of the Provincial Water Act, which revision was completed last November. The complicated subject of water legislation, although established in British Columbia to a degree that has drawn praise and compliment from prominent irrigation authorities, has experienced a severe handicap in the loose methods of administration that naturally prevailed in the earlier history of the province. The efforts to bring water records up-to-date has uncovered numerous vagaries and clauses uncertain in meaning. Dissatisfaction among water holders brought about the passing of the Act in 1909, and the appointment of a board of investigation. The duty of this board has been to determine existing rights to the use of water in various streams. The making of satisfactory adjucations has required careful surveys and the compilation of accurate hydraulic data. Points for investigation included the minimum and maximum supply and consumption at different periods of the year; the capacity and safety of storage works, the points of water diversion, the lines of canal, the individual points of distribution, and the nature of use.

This work is well under way, and the board of investigation has already held numerous final hearings on many streams where conflicting rights have been for years the subject of warm dispute.

The proposed bill contemplates the expropriation of all private water systems. It will, however, leave the actual water rights on streams standing in favor of the individual owners, the water municipality simply acting as carrier and conserver. The municipality will have government assistance in the formation of its organization and in its preliminary survey and hydrographic work. Its boundaries are to be fixed by the government upon the advice of the investigating board, each district to take care of all the agricultural land within those boundaries that is adaptable to irrigation.

MONTREAL'S INEVITABLE WATER INVESTIGATION.

The catastrophe which befell Montreal toward the close of 1913 will long be regarded by its citizens as unparalleled in the history of any Canadian city. Regretably the civic finger of censure is levelled at its engineering department, and public indignation is running high. The loss of millions, due to forced industrial inactivity, is lightly considered in comparison with the exposure to fire, cold and pestilence, to which the city found itself a helpless victim.

As a result, it is a subject of open comment that the department responsible for the conditions which culminated in such a disaster should be "cleaned up" forthwith; and that no board of investigation can rightly do otherwise than recommend the immediate removal of certain officials.

Montreal, for some reason or other, has allowed to be associated with its administration a reputation for municipal inertness, deep and of long-standing. Efforts to institute improvements in government have, as a general rule, come to naught. We recollect the city's procrastination in the matter of raising the tracks of the Grand Trunk Railway, the elevation of which would now cost the city many times the amount it would have cost when the question first arose. Again, the case of the Montreal's Tramways Company has dragged on through a number of years without apparent attempt at satisfactory solution. The proposal to purchase the Montreal Water and Power Company has had no unsurmountable obstacles in its way, according to prominent authorities. We do not mention these instances except to authorize a deduction that Montreal does not differ from the average city in the matter of putting off the undertaking of large municipal improvements.

These and similar features of the civic situation in Montreal create an impression that it would be unjust to lay all blame of the failure in the water supply to the fact that the City Engineering Department did not have a duplicate service main to throw into commission when it was so badly needed. In a November issue, *The Canadian Engineer* urged the City of Ottawa to consider, again, the inadvisability of depending entirely upon a single pipe line in connection with its proposed water scheme. The Montreal disaster is an instance in which a duplicate conduit would have saved its citizens its cost of construction times over, apart from the existing dangers to life and property.

But the engineering department of the average city does not entertain the blessed privilege of being immune from such contingencies as the above. It operates in accordance with the dictates of the administration, which is representative of the citizens, and in control of all civic expenditure.

Montreal's water situation has been a problem for fully half a century. It has been undergoing solution. The question is: has the progress been hampered by municipal inertness? The board of investigation will necessarily look beyond the past few weeks in its endeavor to provide the citizens of Montreal with an adequate reply to their query—What is the matter?

SPECIALIZATION AND REMUNERATION.

In addressing the Manchester section of the Institution of Electrical Engineers of Great Britain, Prof. E. W. Marchant recently drew attention to the fields of employment open to the electrical engineer. He dwelt to some length upon his opportunities and the financial prospects which they afforded him. He gave it as his opinion that the great majority of engineers engaged in the electrical industry are much underpaid, with the result that many men who have undoubted ability are leaving the profession, to its great detriment.

The Financial News (London), in commenting upon the remarks of Prof. Marchant, hazards the opinion that his statement might apply with equal appropriateness to men of the civil, mining, mechanical, or other branches of engineering.

"In engineering," it states, "as in everything else, there are plenty of opportunities for men to come to the fore. The trouble is that there are so few, comparatively speaking, who possess any initiative; so few who have the ability to see an opening and avail themselves of it at once, before it is closed forever. There is a certain allurement in setting up for oneself as a consulting engineer, or taking up one or more promising agencies. These are, however, stereotyped—the sort of thing that every engineer thinks about at some time of his life. But years of leanness have to be gone through before success comes to the consulting engineer, and even the most promising of agencies require a good deal of hard work before they bring in adequate remuneration. It must be in other and less hackneyed directions that the engineer must look who wishes to widen his scope. Yesterday was for the general engineer; to-day is a day of transition; but there is no possible doubt that to-morrow will be the day of the specialist, and unless an engineer specializes he will remain one of the rank and file, and never be able to get out of his field into one which will offer better prospects."

The specialization that is spoken of is everywhere regarded as commendable within certain limits, as the range of engineering work has become so extended that it is now necessary to specialize in practice. Still, it has an objection in that, rather than bringing about much "widening of scope," the engineer's mind is largely closed against other specialties. There are men of talent who have devoted their labors to the design, for example, of an electrical device, or to the stress diagrams for a truss bridge, until they seem impressed with the idea that their special work is the sum and substance of engineering. There is a tendency here for the young engineer to overlook the opportunities. He lacks, not the ability to see an opportunity, but contact with the opportunity itself. He possesses a remote idea that some day he will be chief engineer or head of a consulting engineering firm, that great works will be done under his direction, that he will plan immense structures and solve gigantic problems. But, as to how these attainments may best be reached, his mind does not go much farther than to think that they will come to him when he is older. This is often the result of narrowness of vision, produced by over-specialization.

It devolves, therefore, that with "specialization for the engineer," one must associate the danger of over-specialization for the young engineer. To it is to be added an admonition to keep well before his mind those things which he hopes to attain, and to work towards them. The specialization necessary, and the remuneration, too, will each strike new levels as he advances.

EDITORIAL COMMENT.

The Canadian Northern Railway has taken a decidedly commendable and progressive step in organizing a special department to devote its energies to the prevention of fire along the company's lines. This new department will have charge of right-of-way clearance, fire patrols through timbered country, and the construction of fire guards through the prairie sections. The prosecution of protective work along these lines is following out the mandate of the Railway Act and of the Dominion Board of Railway Commissioners.

MONTREAL'S WATER SUPPLY SYSTEM AND ITS RECENT FAILURE

HISTORICAL OUTLINE OF THE DEVELOPMENT OF THE $7,000,000 WATER SCHEME—ITS PRESENT SITUATION—THE RECENT BREAK, ITS SERIOUSNESS AND ITS REPAIR

THE City of Montreal has experienced one of the most serious occurrences that could befall any city with respect to the carrying on of business and the safety of its citizens from fire and disease. On December 25th, the reinforced concrete conduit, which provides the water supply for the city, failed by bursting at a place on the line where adjacent engineering work had excavated to the extent of five feet, or so, below the invert level of the pipe and a minimum distance of 17 feet to one side of it. Several opinions have been advanced as to the cause of the break, but it is generally conceded that it has been the withdrawal of that portion of the support, as mentioned. A full inquiry, to be proceeded with immediately, will no doubt determine whether or not this is correct.

A brief description of the construction of the conduit, together with the circumstances connected with it, may be of particular interest at this time. Originally, an aqueduct built by Mr. T. C. Keefer, of Ottawa, provided the water supply for the city. It was an excavation with a depth of eight feet, a main width of thirty feet, and a fall of approximately five inches per mile. This aqueduct conducted the water from a point in the St. Lawrence River about one and a half miles above the Lachine Rapids and distant approximately nine miles from the centre of the city. This point is thirty-eight feet above the level of the water in Montreal harbor.

In 1877, improvements were undertaken, but they were discontinued owing to a change of plan after about 4,000 feet of the entrance end had been widened to 140 feet, and to a depth of 14 feet. A general profile of the aqueduct before enlarging, together with the proposed enlargement, is shown in Fig 1. Since that time, several schemes have been advanced for a greater and better supply. That suggested by Mr. George Janin early in 1904 included a proposed concrete conduit with a daily capacity of 50,000,000 gallons. The object was to prevent contamination, to which the water supply had for many years been subjected. It may be stated that the danger from pollution hailed from two sources. The Ottawa River brought an impure supply into the St. Lawrence above Lake St. Louis at the western end of the Island of Montreal; and there existed a further liability of contamination of water en route through the open aqueduct. Mr. Janin's recommendation provided for the extension of the intake out into the river some 1,400 feet to clear the Ottawa water which kept well to the northerly shore at that point; and also for immunity from infection after leaving the river, by an enclosed supply line. Another feature of his scheme was that, as this conduit would supply water for drinking purposes, the aqueduct would be used as a canal for power and industrial purposes. When this supply line was established the aqueduct would be emptied and extended in width and depth to make it conform in cross-section with the enlargement begun in 1877.

The Construction of the Conduit.—The recommendations of Mr. Janin, then chief engineer and superintendent of the Montreal waterworks, were approved by a board of engineers acting for the municipal council, and the contract was let to Mr. Patrick McGovern, of Boston, on September 6th, 1907, for the sum of $785,000, the chief engineer's estimate prepared in 1905 being $660,000.

Work was commenced on the conduit in October, 1907, and the job was to have been finished before the end of 1908. Owing to infiltrations from the adjacent aqueduct, however, serious delays were experienced on several occasions, and the conduit was not fully completed within the specified time.

The conduit, the general direction of which is shown in Fig. 2, lies in earth of widely varying composition, from stratified limestone rock to clay which is hard when dry but very unstable when wet. The depth of cutting also varies from 10 to 35 feet. A section of the pipe is shown in Fig. 3. It is of horseshoe shape. The radius of the invert is 13 feet, with a thickness of 8 inches. The inner face of the sides and arch constitute a segment of a circle of 4½ feet radius. The thickness of the crown and lower portion of the sides is 8 inches, while on the horizontal diameter, that of the sides is 12 inches. This section gives a clear inside height of 7 feet 3½ inches, and a width of 9 feet. The walls are of concrete reinforced with No. 7 and No. 12 B. W. G. mesh, the larger strands being 4 inches and the smaller 12 inches apart. This reinforcing was used around the whole perimeter, where soft soil was encountered. Where the foundation was firm the steel went to about 1 foot below the springing line. Specifications called for a 1:2:5 mix of concrete throughout. For the invert and lower side the broken stone ranged up to 1½ inches in size and for the crown and upper part to ¾ inch. In no case was the reinforcing to come within 3 inches of the inner walls.

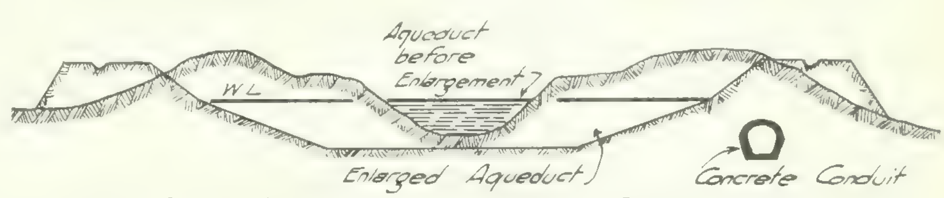

Fig. 1.—Section Showing Relative Position of Conduit and Aqueduct.

The conduit has a grade of 1 in 5,000. Under normal flow the water has a hydraulic gradient of 5 to 10 feet above the top of the pipe.

Other Improvements.—The construction of the concrete conduit was a part of the general scheme of development. A pier about 1,000 feet long had been built at the mouth of the aqueduct to reduce the current in the river. Sluice gates and movable gates in dams, of which

there were two, regulated the level of the water. In 1910, Le Moyne, Fils and L. A. Dery were awarded the contract for the intake, the price being $124,000. The widening of the aqueduct was also proceeded with, and the work was scarcely completed when it was decided to enlarge again with a view to supplying more water for power purposes. Along the enlarged aqueduct there were to be long stretches of boulevarding.

The filters that are being built are also a part of the scheme. Their general design, including the excavation and the construction of the pre-filters and final filters, together with a filtered water reservoir, have been described in previous issues of *The Canadian Engineer*. It will be remembered that in October, 1912, contracts, which had been awarded to the F. H. McGuigan Construction Company in 1911, were transferred to Mr. Norman McLeod. Owing to lack of protection during the winter of 1912, these filtration works suffered considerable damage from the action of frost on the partially completed structures, no provision for protection of the foundation having been made by the contractor. The disturbance by frost resulted in raising and badly cracking the main collectors and floor slabs. The pier bases were raised and tipped. The wall bases were generally raised and some of them severed completely through. Tipping of dividing walls and opening of expansion joints, together with the displacement of the roof groins, were much in evidence. With the warmth of spring, the floor slabs settled, and parts of the structure returned toward their original elevation leaving cracks at expansion joints, and causing considerable spalling.

Failure of the Reinforced Concrete Conduit.—The widening and deepening of the aqueduct has been in progress during the past several years, the present enlarge-

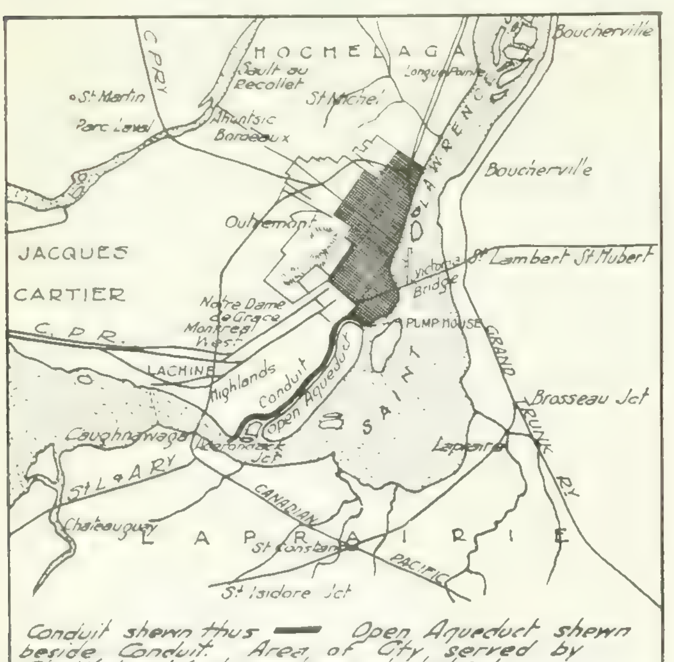

Fig. 2.—General View of Conduit and Aqueduct Location.

ment being carried on by the Cook Construction Company. It constitutes a water-line width of 174 feet and a depth of 18 feet. As may be imagined from Fig. 1, widening to this extent approaches the conduit closely. It appears that about the middle of December, the conduit showed signs of considerable leakage at a point opposite the Verdun Insane Asylum, where the conduit makes a slight bend concave to the Canal, and where the ground consists of loose material. Upon discovery of this the section of the conduit was laid bare and an attempt was made to prevent the leakage by caulking. The canal excavation work was discontinued forthwith. Stone and sand filling were put in behind an outer tier of sheet piling, and on December 23rd the repair work, which had been rushed night and day, was presumed to be efficient and satisfactory.

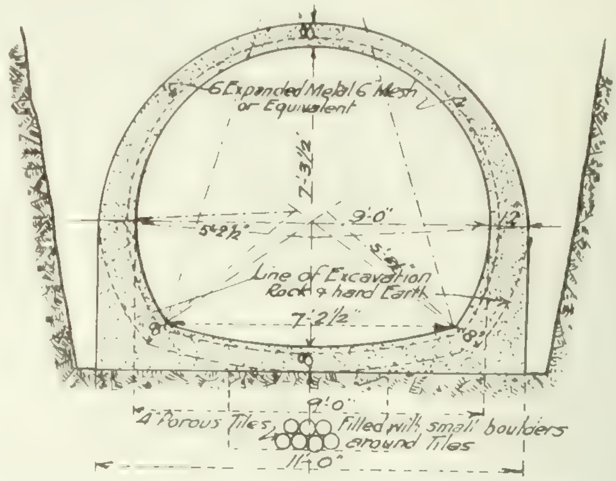

Fig. 3.—Cross-Section of Concrete Conduit.

About 5 p.m. December 25th, a section of the conduit about 60 feet in length broke from the lower portion of the southerly conduit wall at the point mentioned above, and quickly emptied the pipe. Evidently wash and undermining of the pipe had gone on practically unabated. This mishap deprived the City of Montreal, with its population in the neighborhood of 600,000, of its water supply, with the exception of a small domestic supply from the Montreal Water and Power Company, which supplies several suburbs and a few small districts within the city limits; and the distribution of water by carts.

The Work of Repair.—Operations commenced, as soon as laborers could be obtained, to mend the break. It was decided to insert steel pipe into the fissure. While the pipe was being constructed and delivered the break was excavated and the broken portion withdrawn, which operation occupied almost two days. Failing to break the concrete by mudcapping the drag-line bucket which was being used in the aqueduct was utilized as a sledge, and an entire section was removed to the extent of 62 feet. The steel pipe, in lengths of 18 feet, with a ring angle at each end as a bolting flange, was inserted. Seven lengths of it gave a lap of 32 feet at each end. The ends when in position were sealed into the conduit with cement mortar of 1:2:4 mix. The steel pipe with a diameter of 7 feet left a space of one foot on each side, and of 4 inches above and below, between the concrete conduit and the inner shell. Bricks, dropped in bitumen, were inserted as filling, and the concrete was poured directly on the top of the steel tube through holes drilled through the top of the conduit. Steam heating was introduced into the conduit to expedite drying, and coke ovens assisted, at the top and sides of the pipe.

Upon first trial the repair was found to be very inefficient due perhaps to hasty workmanship and insufficient time having been allowed for the concrete to set. The joints, which were equipped with rubber gaskets, were not tightly bolted and the flow of water through them

resumed its undermining effect. This necessitated another emptying of the conduit, and more accurate work being done. The wooden staging supporting the new section was well overhauled. The concrete was more carefully introduced, after all perceptible leaks had been stopped, and was given a full 24 hours in which to set. In the meantime the conduit was very minutely inspected on the inside, throughout its length. As a final precaution large quantities of oakum and bitumen were forced into all interstices which showed any liklihood of weakness.

The head-gates were opened on the evening of January 2nd, and up to the time of writing the restored water supply has suffered no further interruption. Should a repetition of the break occur the old aqueduct will necessarily be put into commission as a means of water supply —a step against which the Board of Health has warned the city because of imminent danger from impurities.

During the eight days' deprivation the civic life of Montreal was in an inextricable state. At three points where the distribution system of the Montreal Water and Power Company approached that of the city, connections were made which provided 15 million gallons a day toward allaying the normal demand for 50 million gallons. Otherwise the circumstance would undoubtedly have been disastrous. Sanitary conditions were becoming alarming; residence heating was severely crippled, while several fires, luckily, mastered in time, showed the extreme helplessness of the situation in case they gained any considerable headway.

The paralytic effect upon industrial activities constituted a loss to be measured in millions. Practically all the large industries, of necessity, acted upon the advice of the mayor and closed down, throwing thousands out of employment.

OIL FUEL.*

By Alfred J. Liversedge.

THE philosopher-historian of the future will pay a good deal of attention to Power—Mechanical Energy—as a factor of the life and growth of nations. When, therefore, he reviews the closing years of the nineteenth century and the early decades of the twentieth, he will note a remarkable expansion in the development and utilization of mechanical energy, throughout nearly the whole of the inhabited globe. He will find this phenomenon manifested particularly in two directions, neither new—one, indeed, old almost as recorded history—but both of which have remained relatively dormant in the past—that is to say, water-power on the one hand, oil-power on the other. It is possible that he will date the rise of an oil age from somewhere about this period. He will surely remark that in the history of organized industry there had not been known hitherto an expansion more rapid in its pace, more remarkable in its character or farther reaching in its effects, than the growth in the use of oil fuel which this period exhibited.

The subject of oil fuel is a very large one, and it would be impossible to do justice to it as a whole within the limits that could be assigned to it here. Fortunately, it divides itself conveniently into several phases, according to the character of the appliances employed to develop the latent energy of the oil. There are three of these general divisions: oil as used for the direct production of light; oil as used in explosion or internal combustion motors for the direct development of mechanical energy; and oil as used in furnaces for the generation of steam, or for metallurgical operations. It is the last of these three phases with which we are here particularly concerned; the others may well be left for consideration on some future occasion, since their importance in industry also deserves our careful attention.

One is so accustomed to associate the idea of fuel with visible combustion in some form of furnace or fireplace that it is, perhaps, desirable to emphasize, in passing, the fact that, whether burned merely for the direct production of light, or consumed without visible flame in the cylinder of an explosion motor, oil is all the time being consumed as a fuel, just as truly as when it is burned in the furnace of a steam boiler. Elementary as this circumstance unquestionably is, it would appear to be often overlooked by those who advocate the substitution of oil for coal. A due recognition of this elementary fact will reveal how wide and varied may be the demand for oil fuel and how many different conditions may require to be taken into account in considering its possibilities in any particular connection.

The whole question has an interest of the first importance; indeed, it may be of a vital character for England. The foundations of the manufacturing greatness of the United Kingdom were laid on the banks of the little streams of Lancashire and Yorkshire, the Midlands, the West of England, the South of Scotland and the North-East corner of Ireland. Those insignificant streams furnished the mechanical energy needed in early days. The superstructure, represented by our position to-day as a manufacturing and commercial nation, has been built with pit coal. In other words, the sources of the mechanical energy by which our eminence in manufactures and in commerce has been won have hitherto been within our own borders and under our own control. The raw material for our greatest manufacturing industry comes entirely from overseas; much the greater part of our wool and a large proportion of our iron come also from abroad; and now it is suggested that we must look outside our borders for the raw material for our power. It is a serious proposition; a proposition which must, certainly, one day be faced, in view of the known limits to our stores of coal; and it is just as well to look at it now while the circumstances permit a calm and leisurelv survey.

Again, it must be remembered that power as a factor of the cost of manufactures is not diminishing in value, it is rather appreciating, and if oil can be substituted on the large scale for coal with the economy which may be attained under certain circumstances, it seems inevitable that the manufacturing centres of the world must gravitate to oil regions, provided only that such regious, of a sufficiently permanent character, are to be found. There, however, lies the crux of the whole position, and the first question calls for consideration.

The use of oil for steam raising is not new. Compared with its employment in explosion motors, its use in association with steam boilers is much the older proposition. Nearly fifty years ago petroleum was tried for some time on a railway locomotive in France, on the line from Paris to Epernay, with results quite encouraging from a

*Abstracted from his article in No. 1, Vol. 1, of the International Review, Dec., 1913.

technical point of view. The speed attained was nearly thirty miles an hour; the oil consumption something under 12 lbs. a mile. About the same time the United States government appointed a commission, of which the chief engineer of the navy was a member, to report as to the feasibility of substituting petroleum for anthracite on ships. The report was favorable, again from a technical point of view. The commissioners found that in regard to evaporation, petroleum had more than twice the efficiency of anthracite, weight for weight, while steam could be raised in one-third the time needed for coal. They, therefore, recommended the government to make a trial on a large scale on one of the ships of the navy, which was done. There were oil enthusiasts then as now, the claim being made that the net saving which the use of petroleum could effect on such a vessel as the then great Cunarder, the "Persia," would amount to $10,000 a trip.

The report of the United States commission was severely criticized on this side, but excited our own naval authorities sufficiently to lead them to make experiments and investigations as to the possibilities of the new fuel—at the time crude petroleum merely was in question. The whole proposition, however, collapsed on the publication of the results of the trials in the States, the conclusions arrived at being that the evaporative efficiency of petroleum as compared with anthracite was only 1.38 to 1, and thus fell far short of the theoretical anticipations, while, generally, "convenience, comfort, health, and safety, were against the use of petroleum in steam vessels, the only advantage proved being a, not very important, reduction in bulk and weight of fuel carried."

The world, of course, has moved since that time; what is more, the cost of oil has gone down with an enormously increased production, while the price of coal has gone up. Even so, until recently it was almost solely in connection with railway locomotives that the use of oil fuel for steam raising had been developed on any large scale. Naturally, the convenience of a liquid fuel which could be supplied and carried as easily as the water needed has appealed powerfully to railway engineers, and nearly every line of any importance has made experiments, more or less, with oil fuels.

In this country, (England) it may be said, the Great Eastern has, perhaps done more in this direction than any other of our railways. In the early stages of this development it was largely a question of utilizing the waste residues of the oil fields because they were waste, and thus relatively cheap fuel. Some interesting problems have in this way presented themselves. Very large quantities of waste residues of the Baku field, converted into a kind of briquette by a process analogous to the formation of a resin soap, have been used on the Russian railways, while the Roumanian railways use similar residues from the Roumanian oil fields combined with their lignite, soft, brown coal. It is obvious that in such cases it is the waste character of the residues which is the determining factor in their utilization as fuel, while it is also clear that this very character must limit the use to relatively local regions.

Needless to say that on the oil fields themselves these residues are utilized as far as possible for heating purposes. Such residues are so used in the works of the Scotch shale oil industry.

It is quite natural to find that in the United States the use of oil fuel on locomotives has been more fully developed—and, perhaps, on more scientific lines—than in any other quarter. The Southern Pacific alone, on its lines in Oregon, Nevada, Utah, California, Louisiana, and Texas, and on the steamship lines which it controls, uses over 25,000 barrels, about 3,500 tons, of fuel oil a day, or nearly 9,000,000 barrels a year. The company has now over 800 locomotives burning oil fuel. Tests made by the engineers of this company have shown that where the mileage per ton of coal has been 5.7, the mileage per barrel of oil has been 1.63, equivalent to 11.4 per ton of oil. The total consumption of oil fuel by the locomotives of the United States, which in 1910 was nearly 24,000,000 barrels, or 3,400,000 tons, is now, probably, at the rate of 28,000,000 barrels, or 4,000,000 tons a year, which, if the tests just mentioned may be taken as a fair guide, is equivalent to 8,000,000 tons of coal. The railways of the States also use large quantities of oil fuel at their depots in the furnaces of stationary boilers. The railways of Mexico and of Austria-Hungary are also now largely operated by oil fuel.

In Canada the Canadian Pacific are using oil on their main line from Kamloops to Field, British Columbia, while the Grand Trunk are also using some proportion. At present these companies have to obtain their oil from the Californian fields, but it is apparently expected, or at least hoped, that future discoveries in Alberta and British Columbia may place the companies in a better position, in due time, in regard to this class of fuel.

It has always been on board ship where oil fuel has been expected to display most fully its advantages over coal. Certainly there is nothing like marine experience to test the merits and develop the capabilities of a fuel proposition, and there can be no question that very great improvements have been made during recent years in the construction of the apparatus employed to burn oil fuel in the furnaces of steam boilers. All the appliances used for this purpose operate by spraying or pulverising the oil with the object of "atomizing" it to the fullest possible extent and thus securing perfect combustion. In a recent French technical journal twenty-three different systems of such oil burners were illustrated. The systems mostly employed may be divided into three classes, as follows:—

1. Spraying by steam jet.
2. Spraying by compressed air.
3. Spraying solely by mechanical pressure on the oil.

The first is the cheapest arrangement to install, but apart from other objections which may be raised to it, so far as ships are concerned, it is practically put out of court by the fact that it necessitates an extra supply of fresh water, a serious consideration where all the fresh water must be distilled. Air-spraying has attained a certain measure of success, but it is the third, or pressure system, which is now being most generally adopted. The British Admiralty use the pressure system exclusively. Very successful apparatus embodying the principle of mechanical pressure are represented by the Babcock and Wilcox system, which has been fitted to over 300 boilers, equivalent to about 500,000 horse-power; the Wallsend-Howden system, made by James Howden & Co., of Glasgow; and the system supplied by Messrs. Kermodes, of Liverpool, who were the pioneers of this method of oil burning. There is no reason to question the substantial accuracy of the evaporative results said to have been obtained by these systems of oil burning for the raising of steam.

The oil fuel used for steam raising on board ship may vary considerably. It may be shale oil or crude petroleum, or any fraction or combination of fractions of

crude petroleum, left after the spirits and (generally) the illuminating oils have been removed, except that it must have a certain limpidity to permit it to flow freely, when slightly heated, through the pipes of the oil burners. The latest specification of the British Admiralty does not permit a lower flash point than 175° F.-Abel close test, or more than 3 per cent. of sulphur or 0.5 per cent. of water, but within the broad limits thus allowed the oil may be anything. As commonly sold as fuel oil, the calorific value may range between 17,000 and 20,000 B.t.u. The best Welsh steam coal will have a calorific value of from 13,500 to 14,500 B.t.u., hence the theoretical relative heating values of oil fuel to the best coal may be taken as 18,500 to 14,000, or the oil has not quite 33 per cent. more value than the coal. A much higher relative efficiency is usually claimed, and must be admitted where average bituminous coal is made the basis of comparison.

Some exhaustive tests made by the U.S.A. naval authorities gave an average relative efficiency expressed in lbs. of water, evaporated from and at 212° F., of 14.45 per lb. of oil consumed to 9.31 per lb. of anthracite coal, thus giving the oil an advantage of over 55 per cent.; but it would certainly appear that a better result should have been obtained from the coal, as it no doubt would be in the best modern steam boilers burning the best coal. As a matter of fact, another series of tests by the same authorities, using hand-picked Pocahontas coal, having a calorific value, dry, of 15,200 B.t.u., gave the relative values of 14.2 for the oil and 10.9 for the coal, the advantage of the oil being thus a fraction under 33 per cent. Still it may be taken that oil fuel has an advantage over good coal of from 33 to 55 per cent. in heating value. It is, of course, this undoubted higher value, *combined with the other advantages* of liquid fuel, which is leading to the adoption of this fuel for ships, and appears likely to result in its use to the exclusion of coal, by all the war navies of the world.

A very competent authority has recently stated that, "The time is fast approaching when oil will be exclusively adopted for all ships, notwithstanding possible higher cost, estimated at 33 per cent., when allowance is made for higher evaporative efficiency." So far, however, the actual tonnage of shipping driven by oil fuel is a very small proportion of the shipping of the world. Probably the total number of merchant vessels now fitted for burning oil fuel does not exceed 250, representing, perhaps, 700,000 tons gross, and very few of these burn oil fuel only. These are exclusive of oil-tank steamers, which now constitute a fleet of something over a million gross tons. In the Pacific, naturally, the conversion into oil burning is proceeding rapidly for the same reason that the United States railways and the railways of Mexico and of Austria-Hungary have so largely adopted oil—the fuel is at hand.

Nor is the proportion of the fighting vessels of the world burning oil fuel as yet very large. Most modern torpedo-boats and destroyers burn only oil, but of the battleships and cruisers none burn oil exclusively. The newer ships are fitted to burn either coal or oil, but coal still retains an enormous preponderance, and must for some time keep it, as the fuel of the fighting ships of the first class. Hence the interest which has been aroused by the announcement of the U.S.A. naval authorities that their new super-Dreadnoughts shall burn oil only, and of our own First Lord that the British Admiralty, in certain of our newest vessels, will follow the American example. At the moment it would appear that the German navy is, perhaps, more completely fitted for oil burning than any other navy of the world.

The situation on land in regard to oil fuel is a very interesting one. Professor Vivian B. Lewes, in the admirable little work on "Oil Fuel," recently issued as one of the "Nation's Library" series, remarks, "At the present time the internal combustion motor plays not only the most important part in power reduction, but also in fuel economy." The statement cannot, of course, mean that gas and oil engines now develop a greater amount of power than the steam engine, but undoubtedly the time is coming when they will do that. At the moment, however, while oil is, to a certain limited extent, through the medium of the oil engine, displacing coal as a source of mechanical energy, it is not displacing coal to any appreciable degree as a fuel for steam boilers in the great manufacturing centres of the world, and that for obvious reasons. The present price of oil fuel in this country, for example, is $17.50 a ton in bulk ex wharf; it was recently more, and may be so again at any time. Thus, granting the highest value, from a calorific point of view, claimed for oil fuel, it is still more than twice as costly as the best steam coal, and up to three-and-a-half times as expensive as other good coal, according to locality. We are thus brought back to the crux of the whole question of oil fuel. What are the prospects or probabilities in regard to the supplies? It is impossible to deal fully here with this vital point, but one or two general considerations may be briefly set out.

Our most eminent authority on mineral oil, Sir Boverton Redwood, opens one of the sections of his great work on "Petroleum" as follows: "In the solid, liquid or gaseous forms bitumen is one of the most widely diffused of substances. It is found in greater or less quantity in almost every part of the globe, while its geological limits include the whole range of strata, from the Laurentian rocks to the most recent members of the Quaternary period." Almost exactly the same thing may be said of gold; but, meanwhile, the actual production of mineral oil, notwithstanding its wide dissemination through the rocks of the earth, does not keep pace with the world's needs. The countries of the world now producing a million tons or more of petroleum a year are the United States, Russia, Mexico, the Dutch East Indies, Roumania, and Galicia. The oil of these countries accounts for 97% of the world's output at the present time.

Of these countries the Russian and Galician productions appear to be actually declining; the increase in the output of the United States in 1912, as compared with 1911, was trifling—if, indeed, there was not an actual decline. The productions of the Dutch East Indies and of Roumania are slightly gaining, but the only one of these great oil regions which shows any important expansion is Mexico. What appears to be happening in most of these regions is well illustrated by the case of the United States, and, after all, the States still provide practically 60 per cent. of the world's output. The production of crude petroleum in the States for the three years, 1904-6, was 50,400,000 tons. The output for the following three years, 1907-9, was 70,370,000 tons, an increase of 20,000,000, or 39 per cent. The yield for the three years, 1910-12, amounted to 87,000,000 tons, representing a gain on the receding triennial period of 16,600,000 tons, equivalent to 23 per cent. Thus the rate of increase in the production of the States is rapidly falling off. It

remains to be seen what will be the next phase, but there can be little doubt as to what it must prove to be.

It must be remembered that the production of mineral oil in the United States is no longer confined to a small area—as is still the case in Russia, for example. Every State in the Union has been exploited for oil, and at the moment seventeen States contribute supplies. It would appear, therefore, that the United States cannot hold any more new oil regions, and that if the output is to grow, or even to maintain its present dimensions, it can only be by more perfectly exploiting the existing fields.

In the British Dominions there is only one region which yields any appreciable amount of mineral oil—Burmah; and while the production of Burmah, with some other regions of British India, shows a gratifying expansion, the total does not yet amount to a million tons a year. The production of Canada is trifling and is not increasing, while Trinidad, of which so much has been expected, is still in the "hopeful" stage.

Nor can it be too often or too insistently impressed upon everyone interested in the question of oil fuel as a substitute for coal for steam-raising on land or sea that the proportion of the petroleum of the world available for use in this connection is very small even now, while the rapid development of the spirit-motor on the one hand, and of the oil-engine on the other, is certain to make that proportion much smaller in the immediate future. Moreover, while much may be expected in due time from modified methods of treating coal, and something from shale, at the moment petroleum represents practically the only source of oil fuel.

It is obvious, therefore, that a policy of the most careful circumspection in regard to the adoption of oil fuel, whether in the Navy or in the mercantile marine, or for use on land, can be the only safe policy for this country to pursue. The authorities of the U.S.A. navy are under no misapprehensions in regard to the chances of oil fuel, and one cannot better conclude the present writing than by setting out the following extracts from a recent letter of Mr. Secretary Lane to the Secretary of the Navy. Mr. Lane remarks: "Crude oil will be available, particularly in Californian fields, for at least a generation to come. . . . . Twenty years hence the price of fuel oil, which then, as now, will be produced chiefly in California, will be much higher than at present, and the production will probably have seriously declined. . . . No relief can be expected in the price of oil fuel at Atlantic ports for commercial uses. Relief for the navy can probably be secured only by the development of its reserves, where it should be possible to produce oil at approximately the present price of 50 cents or less per barrel plus the cost of transportation."

The safety of St. Paul's Cathedral, London, England, which has caused a great architectural controversy for several years, continues to exercise the minds of engineers. It has produced the suggestion that the foundations of the cathedral should be immersed in a moist earth tank. It is proposed to utilize the blue London clay subsoil as a floor on which to build a reinforced concrete wall below the street level of the cathedral and then water the enclosed earth by vertical perforated pipes. It is argued that the recent alarming subsidences are not due to traffic vibrations, but that the moisture has been drawn off the foundations, leaving the foundations parched and unstable and tending to spread.

CONTRACTS AND SPECIFICATIONS FROM THE STANDPOINT OF THE CONTRACTOR.*

By C. A. Crane,

Secretary of The General Contractors' Association.

A CONTRACT, according to the legal definition, is an agreement, for a consideration, to do or not to do a certain thing. Construction contracts usually consist of four elements, the proposal, the plans, the specifications and the contract proper. As you all know, the proposal contains a brief description of the work contemplated, the preliminary quantities and instructions for bidders as to how, when and where bids will be received, the amount of security required, etc. The plans indicate the location and general design of the work; the specifications describe the method of construction and the materials; and the contract itself is the motive power that carries the work to completion. No matter how theoretically perfect a set of specifications you may devise, their successful attainment depends largely upon the form of contract.

In one of the Paris cemeteries there is a fine equestrian statue of a French military hero. The horse is shown rearing aloft at an angle which excites admiration for the nicety in which the balance has been calculated, with the rider gallantly pointing his saber in one hand while with the other he grasps the reins in the tug which has apparently caused his horse to rear. I say apparently, because the sculptor omitted the reins—and it is related that when he discovered this omission his chagrin and mortification drove him to suicide.

Many a piece of work, otherwise faultlessly prepared, has failed because the reins were lacking—the contract form was defective.

We are frequently told that contract forms and clauses are matters for a lawyer to look after—that the engineer is concerned solely with the proper fulfilment of the specifications. It is just because of that view, that so many contracts are a failure. The contract, the plans and the specifications are inter-dependent, and their combined strength is not stronger than its weakest part. The essence and terms of the contract are as much a part of the engineer's province as the plans and specifications. It is the lawyer's province to put into proper legal form the ideas which the engineer desires incorporated. You wouldn's consult a lawyer to draw up your will, and leave the matter of bequests to his discretion. You need him to attend to the legal phraseology and nothing else. And yet too many of our contracts—especially government and municipal contracts—are left entirely to be drafted by the legal departments. The result has been that the engineer is endowed with powers which he never would have thought of himself, and the possession of which sometimes proves embarrassing.

Now, possession of power doesn't necessarily imply misuse of power. History teaches us that there have been many absolute monarchys that have dispensed wise and beneficial government. On the other hand, we've read of some which were quite the reverse. It's the use of power that demonstrates the fitness to possess it—and sometimes it's very costly to determine that fitness.

The broad-gauge engineer knows how to wield this power. But the chief engineer cannot be always on the work—in the field—and his lieutenant, the engineer in

* Paper read before the Society of Municipal Engineers of Philadelphia, Dec. 9, 1913.

immediate charge of the work, is clothed with all the powers of his superior in his absence, and the success of an undertaking often depends upon his judgment and the ability to make instant decisions.

Here are some clauses in Philadelphia contracts which are typical of this power:

"**Changes; Separate Contract.**—Should the Director of the City of Philadelphia change the design or specifications, or both, or any part of the work during its progress, the Contractor shall conform to such change, and the value of the changes, as made, shall be estimated by the Chief Engineer, approved by the Directors, and accepted by the Contractor as final, and no consequential loss of profit on work not executed shall be estimated to the Contractor. The Contractor shall apply in writing for an estimate of the value of the change at the time the change is ordered, and before the next succeeding estimate and payment. Any change to be made at an increased cost of the work shall, at the option of the Director, be executed under separate contract therefor; the work under a prior contract shall be suspended, if necessary, until said changes are completed. The Contractor shall give every facility for making these changes and will not be allowed compensation for delay, except by an extension of the time for the completion of the contract.

"**Construction of Specification.**—To avoid disputes and litigation it must be expressly understood by the bidder that the Chief of the Bureau of Water shall construe this specification, and explain any obscurity herein, and shall have the right to correct any errors or omissions, and shall decide as to its purpose and intent, and his decision upon any doubtful or disputed condition, when approved by the Director of the Department of Public Works shall be final and conclusive and binding upon the City of Philadelphia and the Contractor.

"**Extra Work.**—Whenever, in the opinion of the Director of the Department of Public Works, it shall become necessary to use materials or perform labor which is neither contemplated in the plans of the work, nor implied in the specifications referring to said plans, the Contractor hereby agrees to furnish such materials and perform such labor as extra work, and agrees to accept in full payment therefor a price which shall be fixed by the Director of the Department of Public Works."

What a chance to make the contractor who wasn't in right wish he had never got in at all!

These clauses are clubs, nothing less, in improper hands. If there be any truth in the legal definition of a contract implying a meeting of the minds, there can be no justification for a clause which contemplates the total disregard of one of the minds when any change from the original intention becomes necessary or advisable.

Now, this has been met with the argument that the contractor in signing such a contract, agreed to those provisions, and that the meeting of the minds, for all legal purposes was evidenced by the signatures of the two contracting parties. This is of course true and it is also true that if the advice of counsel were sought every time a contractor intended bidding, he would undoubtedly be told either that he was a fool to sign such a document, or that its provisions could be broken in a court of law.

The success of a contract lies in its manner of execution—not in its wealth of legal protection for the contractee.

So long as the bidding on contracts is unrestricted and the law provides that the award shall be to the lowest bidder, the contract must of necessity be so drawn as to protect the contractee from dishonest practices, not only the dishonesty of contractors but of public officials as well. Contractors can hardly object to this condition nor deny its necessity, but what they do object to is that many clauses which are inserted in the contract more for protection than literal enforcement are often applied to them regardless of good and substantial performance because some inexperienced young engineer who is in charge of the work insists on strict compliance with the specifications. It is one of the difficulties which confront both the contractor and the fair-minded engineer in charge of the work to decide when a contract is not a contract, and these "club clauses," as they are called, furnish the text of the problem.

A prominent contractor in an address some years ago made the statement that if the engineer demands in full that every and all conditions of the specifications be carried out, the job is a failure financially. He went on to say:—

"Every unnecessary or unfair clause in a specification has its part in limiting competition and in lowering the standard of honesty among contractors. A clause that may be used as a club can be avoided in one or two ways—either by not bidding on work governed by the clause, or by using graft in ensuring that it shall be a dead letter."

This second alternative, however, is not always resorted to to avoid the effect of club clauses. They are put in there, as said before, more as a matter of protection than of information. They are to be treated as the chief engineer of one of our greatest public improvements told one of his assistants: "You must use your judgment in interpreting some portions of this contract; they are only meant for bad contractors." So it's evident he thought there were some bad contractors—but he must also have felt there were some good ones—and was able to differentiate.

In almost every contract the chief engineer is the arbiter of all questions and his decision is final. This clause has been kicked at and sued about and condemned by contractors perhaps as much as any other one thing in contracts. And yet there are thousands of contracts, containing just such a clause, completed with never a murmur. So we must conclude that in the long run the engineer is the proper party to wield this authority and that it has been wielded fairly. It bears testimony that the engineering profession as a whole is conducted on a high plane of honesty and intelligence—not even the learned profession of the bench and bar can point to so few reversals by higher authority. But there are exceptions—you all know of them—and it is those exceptions that cause the trouble and turn the contractors' profits into lawyers' fees.

We come back to the use of this power of absolute determination. How can an engineer who is employed by a party to the contract and is virtually the agent of that party render a fair and impartial decision when a dispute arises relative to the work which he himself designed and of whose requirements he is presumed to know more than anyone else? Simply by bearing in mind that the contractor also is an agent of the same party—not an enemy who must be outwitted.

Now, we have heard the adage, "Knowledge is power"—but oftentimes this power conferred by the contract is vested with an engineer before he has the know-

ledge. Some engineers are too narrow to realize that a specification is a standard, and that an approximation to that standard fulfils the contract. The man who rejects masonry because the joints deviate a fraction from the specifications, or piles because they are a half-inch under size at the butt, doesn't appreciate that he is standing in his own light—he never becomes a big engineer—he never has time to learn engineering—he is too busy inspecting.

It is amusing, sometimes, to note the very radical change of views which an engineer undergoes when he ceases to be the engineer for the contractee and becomes either a contractor himself or an engineer for a contractor. The very policies which he so tenaciously followed become most repugnant to him now that he is forced to toe the same mark himself. In fact, a prominent contractor who is to-day the president of a large contracting firm, stated in a public address that he could speak understandingly and feelingly on the relations between the engineer and the contractor because for the first few years after graduation he was employed as engineer for the owner and that now, when he looked back upon some of the ideas which he felt inspired by a conscious duty to enforce, he felt that he ought to pay a personal visit to certain contractors and try to square himself for the damage he had caused.

The knowledge requisite to use this power comes only through experience—and unfortunately there are some personalities that can never assimilate it in a bi-partisan spirit. Such men have never been able to find out for themselves whether there really was any room at the top or not—and rather doubted it anyway. But most of the mistakes arise through an excess of zeal rather than from any desire to be drastic. Not long ago an instance of this came to my notice. A young engineer not long out of college was in charge of a party on one of the tunnels in New York and he was very much concerned over the method of timbering employed by the contractor in a piece of bad heading. He insisted on some changes but the contractor intimated that the suggestions weren't feasible. The chief engineer happened along and the young engineer complained that his orders were not being obeyed. The chief took him aside quietly and told him that they were very fortunate in having this particular contractor on that piece of work—he had been driving tunnels for over thirty years and knew more about timbering than the chief himself, "and," he remarked, "I guess we better let him do it his own way."

In this case there was no harm done—the matter was so tactfully adjusted by the chief that his subordinate suffered no loss of dignity—and the work was not endangered at a critical point by ill-timed experiments. Had the engineer prevailed, and his method failed, would the contractor have been responsible?

This brings us to a clause which is frequently found in contracts, which holds the contractor responsible for the performance and safety of his work while the method of construction is specified.

The specifications provide how the work shall be done, what materials shall be used, and the contract contains a clause shunting upon the contractor all responsibility for the accuracy and sufficiency of the plans to produce a structure that will insure a desired result. The contractor is required to guarantee the efficiency of the completed work without having a word to say as to its design. This is manifestly wrong. The contract should prescribe only one of two things—either the design or the performance. It should not stipulate both, for if it should occur that the design were insufficient, the contractor should not be held for the failure in performance. Contractors may be pardoned for feeling that the engineer who attempts to shift the responsibility for the work which he himself is paid to assume, upon a contract or is technically dishonest and betrays a lack of faith in his own ability. In such cases the courts will not always uphold the engineer.

An important case involving this very point was decided by the United States Court of Claims within the past year in what is known as the Boston Dry Dock case. The contract provided that the contractors would, at their own risk and expense, furnish and provide temporary structures of every description necessary for the construction of the dry dock, subject to the approval of the engineer in charge. A question arose about the design of a coffer dam and the engineer in charge designed a structure which the contractors protested was insufficient, but upon the insistence of the engineer they built it. It subsequently failed. The court found that the defects which caused the failure were such as an exercise of ordinary care and skill on the part of the government engineer would have foreseen, and awarded the contractors their claim for damages.

It is impossible to over-emphasize the importance of the relation of the engineer who is in direct charge. He is called upon to give immediate decisions on important questions, in the absence of his superiors. He is clothed with all the powers conferred in the contract and these are liable to be over rather than under-exercised by the too zealous and inexperienced engineer. Care in the selection of his deputies, and personal attention to their training by a chief engineer are tremendous factors in securing harmonious relations with the contractors. Constant bickering prevents good work, and the chief engineers who have been most successful are those who have impressed upon their subordinates the realization that tact and diplomacy win more battles than obstinacy.

There has been some agitation within the last year by some engineers and contractors to reform the present contract system by legislation—to enact universal statutes governing contract provisions. Personally, I am not a believer in the power of legislative enactment to effect any such reform. The engineers to-day have all the power at hand to revise, standardize and perfect their contracts that is necessary—statutes merely serve to tie their hands, and no statute can be devised that will fit every case. I believe in giving every latitude to the engineer—he has proved that he is about 90 per cent. fair and the other ten per cent. we continue to wrestle with in the hope of reform.

The attempt to regulate the relations between contractors and public officials and to prescribe by statute for nearly every contingency that may arise in a contract is in my humble judgment a mistake. Laws are no stronger than the men who enforce them, and if it be the fact that laws are necessary to curb our public officials, something is radically wrong with our system of government. You can't legislate honesty into a man—you may render him more cautious, but if he be dishonest he will beat any law you can make. What we need is better men, not more laws, and public office should offer the best men suitable compensation for their services to the public.

If the process of perfecting contract practice, the contractor should be considered. He is the practical factor in the game, and theory must go hand in hand with practice, or the result will be worthless. The contracting business to-day numbers among its members many of the leading engineers of the world, and their experience and advice must not be under-estimated. It wouldn't do for these matters to be discussed just between engineers. Two heads are not always better than one; if they be on the shoulders of two engineers there is apt to ensue a wrangle over technicalities and the subject matter is liable to suffer, but if one head be that of a contractor, expert in his line, and the other an engineer, each equally mindful of his reputation, the result will invariably prove the wisdom of the adage.

Now on the subject of bidding. Bids are usually invited in one of two ways, lump sum for the entire work, or on a unit price basis. There are also the methods of cost plus a percentage and cost plus a fixed sum, but they are not in general vogue. The lump sum method is followed more in building construction, and the owner knows just what the building is going to cost him, provided he doesn't change his mind and the plans too often. The character of the work is such that everything may be provided for and shown on the plans. There are no unforseen contingencies liable to occur that will affect either the plans or the quantities, and the bid is figured directly from the plans and specifications. If anything has been omitted, or any additional work is required, it is a matter of subsequent agreement between the owner and the contractor. Needless to say, these extras are sometimes fairly profitable to the contractor, since the owner is not in as good position to drive a bargain as before the work was awarded.

On engineering works, the unit price system is preferable, because of the impossibility to foretell just what conditions will arise as the construction advances, and with the price fixed on each item, there is less opportunity to claim extras. Not that they are not claimed, but the owner is in a better position to resist the demand than if he were bound down to a lump sum for a specified amount of work. We have already seen how the owner protects himself in the contract by disavowing responsibility for the accuracy of the estimated quantities, and how impregnable his defense is. There are extreme cases, however, where the contractor has won his point, when the original quantities proved to be so far out of the way as to present an entirely different proposition from that contemplated. But with proper investigation beforehand, including soundings and borings, this is inexcusable, and yet bear this in mind—that contractors every day are bidding on quantities prepared by engineers they never heard of—in many cases the job is the first some engineer has had—and he relies on the integrity and intelligence of that engineer and pins his hopes of profit on the accuracy of his survey and his figures. Is there any other profession in whose members so much trust and faith are reposed by utter strangers? If a contractor needs a lawyer he will retain the best he can get; if he needs a doctor he will call in one with an established practice, but he will risk his money on the mere say-so of an engineer he never heard of, who may be bearing the title of engineer merely by courtesy, or because of a correspondence diploma. Isn't it high time that engineers generally paid more attention to the preparation of their work than is so frequently the case?

While we are talking of bids, a few remarks on some peculiarities that they sometimes offer may be apropos. I refer to what is called the unbalanced bid—some call it balanced—but unbalanced seems a better definition. This occurs only under the unit price method of bidding. It is a very common practice for engineers in preparing the schedule of quantities to include items which there is some possibility of needing, in a merely nominal amount. The contractor who is doing work of a similar character in that vicinity believes that those items will not be used, and bids one cent or nothing on them. As it turns out they are not used and he has not lost anything. If they had been used, that would have been another tale. Now the unbalancing consists in placing the cost of an item which the contractor has reason to believe will be diminished, on another item which he is sure will be done, or perhaps increased.

There have been cases where the contractor who bid one cent on timber has been required to put in the full amount, but even should that be the case, he is fully protected by including its cost in another item. Of course, when he bids one cent on timber, he is going to use his best efforts to persuade the engineer that the timber is not necessary and when he bids a high price on an item he is going to be equally as persuasive that the job will be a failure unless a large quantity of that particular item is used. It would seem that the logical way to avoid this situation is to insert in the contract an agreed price for any item which may perhaps be required, but the necessity for which seems doubtful to the engineer in preparing his estimate. In this way every bidder would be on an equal footing and would be competing only on the items which were sure to go in the work.

Now, while there is much to be said on both sides about the subject of unbalanced bids, engineers should not lose sight of the fact that they themselves are directly blamable for any disastrous results. If engineers exercised the proper precautions in preparing their estimates, there would be no reason to fear the unbalanced bid, nor would there be any necessity for devising methods which would prevent them. Avoid unbalanced quantities and the unbalanced bid will disappear except occasionally where the contractor bases his price upon the work which is first to be done in order to get his largest payments at the start to finance the job.

There is very little unbalanced bidding on the contracts for the Catskill Aqueduct or for the subways. The estimates have been carefully prepared and the contractors generally have bid a suitable price on each item—but where a contractor has reason to believe the engineer's quantities are wrong, he should be privileged to use his own judgment in preparing his bid.

Bear in mind that a contractor is most generally a human individual—not nearly so wealthy as the newspapers love to depict him—and that for every crooked contractor there has been some crooked official somewhere in the offing. My experience with contractors, and it has been my privilege to know a great many, has led me to believe that they are as honest a lot as in any other line of business or profession. As an afterdinner speaker in the course of his remarks stated, it is one of the peculiarities of human nature that the indiscretion of one woman makes more noise than the good conduct of a thousand. And this is quite applicable to contractors, too.

MECHANICAL AND ELECTRICAL EQUIPMENT OF HOTEL FORT GARRY, WINNIPEG.

The power plant equipment for the Hotel Fort Garry is a notable instance of the placing of the complete equipment in the hands of one engineering firm instead of purchasing the various individual pieces of machinery and apparatus from various sources. The advantages of placing the entire responsibility on one company are apparent even to the layman. An engineering firm manufacturing equipment which has a reputation for satisfactory operation and economy, should be in a position to provide and install the complete equipment, eliminating the division of responsibility and insuring the purchasers an installation in which the various pieces of machinery and apparatus bear the proper relation to one another and are so proportioned as to give greatest satisfaction.

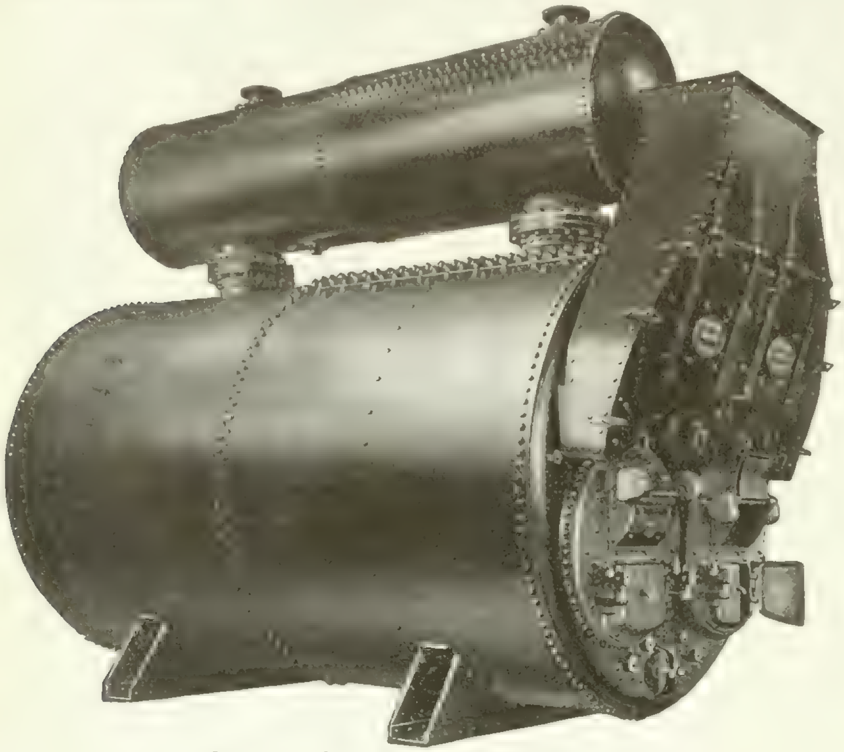

Fig. 1.—One of the Four 300-h.p. Boilers.

The International Engineering Works, Limited, of Amherst, N.S., undertook the complete power plant equipment of this hotel in accordance with the drawings and specifications prepared by Ross and MacFarlane, architects. The broad scope of this installation is shown from the fact that they were to supply not only the Robb boilers, engines, etc., of their own manufacture, but were to fit into the general scheme such other machinery and apparatus as would provide for refrigeration, electric light, water softening, etc., these larger pieces of apparatus of course to be accompanied by their accessories such as feed water heaters, boiler feed pumps, service pumps, switchboards, etc.

The four boilers selected for Hotel Fort Garry are of the Robb Scotch type which are internally fired. These boilers each of 300 horsepower are a modification of the standard Scotch marine boiler, the chief difference being the division of the one large drum into two drums. In this case the steam drum, 18 inches in diameter, is connected by short necks to the large shell 120 inches in diameter containing the two furnaces, combustion chamber and 220 three inch tubes 14 feet long.

These boilers are equipped with corrugated furnaces 40 inches in diameter extending from the front to the combustion chamber. Although internally fired these boilers have very rapid circulation, which is accomplished by means of a circulation plate at the front which compels the water from the drum to pass around the shell and rise between the furnaces and amongst the tubes passing to the rear. The two features which contribute to the high economy of this boiler are rapid ciruclation and internal firing.

Another product of this company that was utilized, was the Macdonald shaking grate. These grates were supplied to all eight furnaces. They are of the shaking type with removable tops which reduce repair expense. The improved locking device insures long life by preventing any possibility of the points becoming burned off.

The three Robb vertical engines are of the compound, high-speed type direct-connected to 200 k.w. generators. The cylinders of these engines are 18 and 26 inches in diameter with a stroke of 10 inches. Their high speed,, 360 r.p.m., makes them ideal for direct connection to generators as well as furnishing a very powerful prime mover occupying a small space. An automatic system of lubrication which provides for pumping the oil by the engine itself to every sliding and revolving surface reduces care to a minimum, and complete enclosure of all moving parts insures perfect cleanliness of the engine room and protects the parts from accidents. These engines are also supplied with oil guards which prevent the oil creeping along the shaft to the generator.

The compound engines are operated at 120 pounds initial pressure and with five pounds back pressure have sufficient capacity to carry 25 per cent. overload on the generators. The automatic shaft governor is so sensitive that the speed does not vary more than 2 per cent.

The generators are compound-wound, manufactured by the Canadian Westinghouse Company, Limited, Hamilton. To fulfil the specifications these generators had to operate continuously without blackening the commutator and carry 25 per cent. overload for two hours with an increase in temperature not more than 55 degrees C. The International Engineering Works, Limited, through sub-contractors, the American Water Softener Company, installed a water softener of 6,000 gallons capacity per hour, with settling tanks 10 feet in diameter and 22 feet high. The water softening apparatus softens the water through chemical solutions so that the scale matter does not exceed five grains per United States gallon.

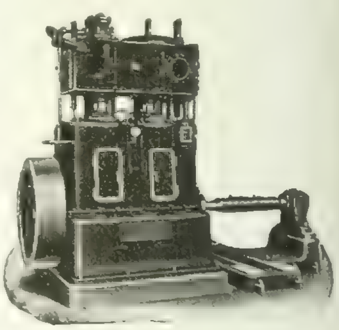

Fig. 2.—Type of Engine Used.

The refrigerating plant of Hotel Fort Garry consists of a 30-ton refrigerating outfit. Two 15-ton double-acting ammonia compressors made by the Linde Canadian Refrigerating Company are driven by two slide valve engines. The installation includes double pipe ammonia condenser with brine cooler, liquid ammonia reservoir, and brine storage tank. On the roof of the hotel there is a 5-ton condenser piped through the building to charcoal filters placed in series and double-pipe cooling coil.

COAST TO COAST.

Victoria, B.C.—Considerable discussion is being given to the advisability of the use of brick or concrete pipe in the north-west sewer construction. The city engineer is preparing a report upon the merits of concrete pipe.

Winnipeg, Man.—Recently, Reeve Bannatyne of Assiniboia, officially turned on the electric current at the St. James power house, setting in lumination 61 arc lights along Portage Avenue, west from the city limits to Headingly.

Woodstock, Ont.—One of the first problems with which the new town council will be called upon to deal, concerns the decision as to the application of the Maine and New Brunswick Power Company to bring its electric power to Woodstock.

Ottawa, Ont.—At Ottawa, 1913 has proven to be a record year in granolithic walk and macadam street construction. About 14 miles of walks and crossings were laid, while about 10 miles per year is the average mileage. Also 5 miles of asphalt pavement were laid.

Ottawa, Ont.—The financial statement for the township of Gloucester for 1913 shows the income to have been $47,-464.53; the expenditures, $46,450.28; and the surplus, $1,-014.25, the greatest the township has yet had. One of the most important works accomplished was the construction of the road from Gloucester to Cumberland at a cost of $1,170.10.

North Burnaby, B.C.—On December 23rd, the new extension of the Hastings Street east railway line to a point near the foot of Capitol Hill, was officially declared open for traffic by Reeve McGregor. Members of the Municipal Council and representatives of the B.C.E.R. Company were present at the formal inauguration; and some of these also took part in the formal proceedings.

Regina, Sask.—It is expected from the indications on the progress of the work of installing machinery and valve connections, that the new water distributing system for the city will be inaugurated and put in operation some time next month. The new pump of a 5,000,000 gallon capacity is expected to arrive early in February, and it is hoped to have all in readiness to mount it on the concrete foundations, and to assemble the parts.

Swift Current, Sask.—The large storage dam across the Swift Current river, which will ensure a supply of water for a population of at least 50,000, was formally opened recently. The dam, which is over 800 feet long and 25 feet high, was constructed by the Ambursen Hydraulic Construction Company, of Montreal, under the supervision of George K. Mackie, town engineer, at a cost of $100,000; and will have a capacity when filled of over one hundred million gallons.

Vancouver, B.C.—Work on the Point Grey partnership pipe has started under the supervision of Mr. J. T. Breckon, the city's new waterworks engineer. Seventy men were put to work on the trench at Chilco and Haro streets in the West End, where the pipe-laying was stopped pending the settlement of the route. This number, however, will likely be increased as soon as the work is properly under way. Waterworks Superintendent Maddison is in direct charge of the construction work.

Edmonton, Alta.—Steel on the Edmonton, Dunvegan and British Columbia Railway construction is reported to have reached mile 131, or where the town of Smith is located. Here, also, a temporary bridge has been constructed across the Athabasca River, which in time will be replaced by a steel structure. Grading has been carried out as far as mile 220, while surveys have been completed to mile 310. The road has advanced sufficiently to permit of announcement by Chief Engineer Smith that a freight service will be put in operation shortly.

Fort William, Ont.—Six hundred miles of double-tracking on the C.P.R. are waiting for steel, and the company has just closed an order for 125,000 tons of steel for this purpose. When that track-laying is completed the company will have on the entire system east and west but 488 miles to be built. The districts where double-tracking is proceeding at the present time are Sudbury to Fort William, Brand to Calgary, and Revelstoke to Vancouver. When this work is completed there will be 1,095 miles of double track between Fort William and Vancouver, and over 200 miles between Sudbury and Fort William.

Orillia, Ont.—The annual report of the water, light and power commission engineer, shows that the average pumpage for the period from May to November, 1913, was 502,090 per diem, or 67 gallons per head of population; and that the heaviest day's pumping was 841,500 gallons, or 112 gallons per head of population. In the electrical department, the report shows the amount of motor power in use to be 1,297 horsepower. Engineer Greenwood makes the comment that the electrical system is now in very satisfactory condition, and it should be possible to improve the record of service during the coming year very materially.

Vancouver, B.C.—It is reported from the office of the general superintendent in Vancouver that work on the "pioneer" bore in connection with the five-mile tunnel for the C.P.R., which is to be driven through Rogers Pass, at the summit of the Selkirk Mountains, is well advanced from the eastern portal; and that nearly 600 feet of the parallel tunnel has been excavated, the present rate of progress being about 5 feet per day. In order to facilitate the driving of the big bore the contractors are adopting a new method of procedure. They are running a small preliminary tunnel from which cross cuts will be made at short intervals so as to enable the workers to attack the larger bore simultaneously at scores of points. This "pioneer" passage will also solve the question of ventilation and provide for a considerable time an exit for removing the excavated material.

Vancouver, B.C.—In connection with the construction of the G.T.P., Mr. Morley Donaldson, vice-president of the company, has announced that at the present rate of progress, the two ends of steel will be connected by May 10; that construction, which is proceeding at the rate of 3 miles a day, 1½ on the western section and the same amount east of Prince George, will be carried on all winter; and that steel will be laid into Prince George by January 10. The Grand Trunk Pacific, during the year, concentrated, for the most part, its efforts on the completion of the main line of the western division, which will connect Winnipeg with Prince Rupert on the Pacific Ocean, and also on the completion of the branch lines in the provinces of Saskatchewan and Alberta, with the result that the 14 separate branch lines under construction in the provinces aggregating a total mileage of approximately 1,000 miles are now about completed. In addition to this, about 300 miles of main track line were laid in British Columbia.

Calgary, Alta.—At the annual meeting of the Industrial Bureau, it was announced in the report of Commissioner Miller that extensive investigations which have been completed by Government engineers, under the direction of Mr. J. B. Challies, superintendent of the water power branch of

the Department of the Interior, [illegible] the power possibilities of the Bow and Elbow Rivers within feasible transmission distance of Calgary, show that on the Bow River alone it is economically feasible [illegible] to regulate the flow as to warrant the development at four power sites of over 40,000 dependable 24-hour horsepower, all within 50 miles of Calgary. The Calgary Power Company has completed an installation at Horse Shoe Falls of a maximum output of 18,000 horsepower, which is mainly transmitted to Calgary; this company will within a few weeks have a second power installation completed at Kananaskis Falls, capable of an additional maximum output of 11,000 horsepower. With these water powers developed there would be 70,000 horsepower available in the Bow River alone.

Toronto, Ont.—Favorable progress is being made on the two Don bridges. The contractors for the concrete foundations of the new duplicate bridge over the east Don, Messrs. Dickenson & Burns, expect to complete the pediments in about two weeks, while the Canadian Bridge Company, of Walkerville, has its construction train and steam hoist upon the ground, and has already unloaded a large number of the girders and the beams for the towers. This bridge is about 1,000 feet in length, its widest span being on the west side and over the C.N.R. It is 80 feet above the C.N.R. and 120 feet above the bed of the river. In addition to the pediments, a retaining wall 8 feet wide, alongside the C.N.R., is required to carry one side of the tower. Over one half of the bridge over the west Don has been completed by the Dominion Bridge Company. This structure is over 800 feet long.

Winnipeg, Man.—The report on civic improvements carried out in Winnipeg 1913, shows a total cost of $1,224,730.60. The total cost of pavement laid by both Engineer of Construction Astley and outside contractors to have been $470,-848. The tender of the engineers of construction for asphalt pavements (No. 1) was $344,000; but the works were completed at a cost of about $11,000 less than that amount. The amount spent on asphalt pavements (No. 2) was $57,969. Small sections of macadam gravel and block pavement also were laid by the engineer of construction; and these as well as the asphalt pavements were laid at costs less than the tender prices. In the case of sewer construction for the year, however, the actual cost, $275,610, exceeded the tender price by about 10 per cent. This, in turn, was more than counteracted by a saving of 13 per cent. on granolithic sidewalks, made possible by the purchase and use of several concrete mixers. The total expenditure for the year on granolithic sidewalks was $116,875.60. The cost of water mains was $174,584, or 18 per cent. above tender price, the extra cost being incurred by the laying of three high pressure mains, and one domestic main during the winter when there was from 6 to 8 feet of frost in the ground. A saving of 3 per cent. and 7 per cent. on tender prices is shown in the construction of concrete pavements and plank walks respectively. The new 18,000,000-gallon reservoir was constructed at the very moderate cost of $307,000, which included the cost of foundations, though not the cost of land. Again, though the cost ($265,-000) of the Osborne Street bridge across the Assiniboine River was mostly paid for in 1912, yet this important improvement was completed last year, the approaches and towers projecting the work well into the summer. Other municipal works on which large sums were spent, were the erection of two hospitals, the building of two new fire stations, extensions to the street railway system, a new police signal alarm service, the improvement of the city light and power plant, the extension of the artesian well system, and some preliminary work in connection with the Shoal Lake water supply. The money expended in the last of these will be refunded to the city by the Winnipeg Water District Board. Of the $750,000 which was allotted to the light and power department, $250,-000 still stands to its credit to be used for the installation of additional turbines at Point du Bois, the contract for which has been let, the work to be completed next spring.

Sarnia, Ont.—The increasing business of the Standard Oil Company is occupying the directors with the devising of plans and means for increasing the present plant of the company to a capacity sufficient to handle all the work that can be ordered. The company has completed the pipe line to the great oil fields of Ohio, and thus has an unlimited supply of crude oil to draw upon at all times in the year. At the present time the company has on its payroll about 1,500 men, many of whom are at the work of rebuilding the refinery and increasing the capacity of all parts of the enormous works. It is reported that during this winter the company will erect over 20 stills, with condensers for the same, and buildings to look after the by-products. Four of these stills are now under erection on the west side of the yard. A start has already been made on a battery of 12 crude stills to be constructed south from the battery now opposite the Pere Marquette Station. A new set of six stills has already been constructed in the rear of the crude stills, and a battery of half a dozen more will be added to these. At the new works, which are about a quarter of a mile from the offices of the company, the work of building the new motor spirit refinery is being rushed. The foundation for a battery of ten stills, each with a capacity of 300 barrels, has been completed, and the work on the foundations for the necessary condensers is in progress. The digging for three large underground tanks has commenced. This work will incur great cost, but is very necessary for the storage of the new spirit, which is used for operating automobiles, as it is very explosive in comparison with the gasoline now in use.

Victoria, B.C.—In connection with the tunnel work on the northwest sewer, two shafts have been sunk at McLoughlin Point at either end of the bluff of rock which interposes between the end of Smith and Robert's streets, and at the junction of Bay Street and Anson Street, with a view to open a tunnel face. A section has been opened in an earth and rock cut a little further south; and although it is deflected from the original point set out for an outfall, to avoid the current washing back sewerage into the harbor, the character of the outfall may be gauged. The intention is to carry the sewerage out to a natural tank which can be contrived by damming up the ends, and covering a basin between the land and an islet of rock at Macaulay Point. From that tank the sewerage will be carried out to sea by a submerged pipe, the exact nature of which has not been determined, but will be dependent upon further tests to be made by the engineers upon the flow of the currents. From the piercing of the two shafts, it has been found that it is particularly hard material through which the tunnel has to be driven. The other large tunnel in Esquimalt municipality is the one at Dunsmuir Street. In this case, as in that of Smith Street, it will be necessary to excavate sufficiently not only for the actual pipe line, but for inspection. The third tunnel of large size will be in Victoria West, the location depending upon the point fixed for the crossing of the Victoria arm with a syphon. Assistant Engineer Payne, after an examination of the character of the district, has recommended to the city engineer that a direct tunnel from the Gorge Road to Dominion Road would be most satisfactory, but the subject is still under advisement. The pumping station to handle the low level sewerage north of the Gorge will be located at Cecilia Road, instead of at the waterside as has been proposed. In this section between Burnside Road and the Gorge waters earth is being excavated.

Vancouver, B.C.—The Burrard Inlet Tunnel and Bridge Company adopted a resolution recently to call for tenders for the bridge to be constructed across the Second Narrows. They took this action in view of the facts that the Provincial Government cannot yet give a definite answer to the company's request for information as to the construction of the proposed Second Narrows bridge, and that the company's charter expires next spring. They deemed it incumbent upon them to have some tangible evidence of their intention to proceed with the proposed construction, so as to strengthen their application for renewal of the charter privileges. The company is capitalized at $3,000,000, of which sum one quarter has been subscribed by the municipalities interested. The Dominion Government has granted a subsidy of $350,000, and the Provincial Government a subsidy of $400,000. Thus more than one-half of the total amount required for the project has been assured. The Provincial Government will be asked to guarantee a bond issue of $750,000, the amount upon which the company is allowed to raise funds under the terms of its charter. The structure will be of steel with wide spans, and will be supported on six piers founded on rock. The draw span will measure 581 feet 6 inches in length from centre to centre, and will revolve on a platform supported by four wrought steel cylinders, braced together and filled with concrete. The fixed spans will be 232 feet long. A clear headway of 45 feet above the level of high-water mark will be provided, and the bridge will cross the Narrows at an angle of 75 degrees to the average direction of the flood and ebb currents, which are very powerful at that point. A channel with an average minimum depth of 35 feet will be dredged to allow the passage of large ships. The bridge will be 64 feet 5½ inches in width. On the west side, a single line of railway tracks will be laid; in the middle of the roadway, which will be 39 feet 5½ inches in width, double street car tracks; on the east side, an eight-foot path for pedestrians. The approaches will be on an easy gradient, one foot in thirty, with a one per cent. grade continuing to the centre. The swing span will be operated by electric motors, and gates, also electrically controlled, will automatically safeguard traffic when the draws are opened. Wrought steel trestles will support the approaches to the bridge, strongly reinforced with longitudinal arms resting on concrete foundations. The superstructure will consist of wrought steel stringers, supporting deck ties of Douglas fir. The roadway will be paved with creosoted wood blocks; and extra substantial spans will carry the approaches for the steam tracks. Exclusive of the approaches the structure is estimated to cost around $2,225,000.

PERSONAL NOTES

R. G. SNEATH has joined the engineering staff of the New Welland Ship Canal at St. Catharines, Ont.

H. D. CLEMENSON has been appointed by Prince Edward County as commissioner to take charge of the county system of road improvement.

WALTER HAZLETT has been appointed mechanical superintendent of the Canadian Steamship Lines, Limited, with headquarters at Montreal.

PHILIP P. SHARPLES, Chief Chemist, Barrett Manufacturing Company, Boston, on December 27th delivered an illustrated lecture on "The Manufacture of Refined Coal Tar" before the graduate students in highway engineering at Columbia University.

W. NORRIS, general manager of the Chatham, Wallaceburg and Lake Erie Railway, has been mentioned for the position of general manager for the London and Port Stanley Railway. Mr. Norris was formerly engineer of the Winnipeg Street Railway.

ARTHUR N. JOHNSON, M. Am. Soc. C.E., State Highway Engineer of Illinois, Springfield, recently delivered an illustrated lecture on "Economics of Highway Engineering in the Middle West" before the graduate students in highway engineering at Columbia University.

SIR DOUGLAS COLIN CAMERON, K.C.M.G., Lieutenant-Governor of Manitoba, who was included in His Majesty's list of New Year's honors, is vice-president of the Manitoba Bridge and Iron Works, of Winnipeg, and has figured prominently in the engineering development of the West.

E. A. JAMES, engineer to the York County Highway Commission, Toronto; A. J. McPHERSON, chairman, Board of Highway Commissioners for Saskatchewan; JOHN STOCKS, Deputy Minister of Public Works, Alberta, and ALEX. McGILLIVRAY, Provincial Highway Commissioner for Manitoba, were chosen by the Automobile Federation of Canada as consulting engineers to advise the Federation respecting the road construction, improvement and materials most suitable to the needs in their respective provinces.

COMING MEETINGS.

MINING AND METALLURGICAL SOCIETY OF AMERICA.—Annual Meeting will be held in New York City, January 13th, 1914. Secretary, W. R. Ingalls, 505 Pearl Street, New York.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th, 1914. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Annual Convention to be held in New York City, January 16th, 1914. Secretary, J. R. Wemlinger, 13 Park Row, New York City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual meeting will be held in Montreal, Que., January 27-29, 1914. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal, Que.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—Annual Meeting to be held in New York, January 21st to 23rd, 1914. Secretary, E. A. Scott, 29 W. 39th Street, New York City.

COPIES OF JULY 4th, 1912, WANTED.

One of our subscribers is very anxious to obtain six copies of the issue of July 4th, 1912, and would be glad to pay 25 cents per copy for same. Will subscribers, who happen to have a copy of this issue and do not care to keep it, kindly send it into this office, and we will see to it that it is put in the hands of the right party?

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21098—December 2[illegible]—Extending, until June 30, 1914, time within which C.P.R. complete extension of existing siding for Quinlan and Robertson, in Lot 10, Con. 8, Tp. Huntingdon, Co. Hastings, Ont.

21099—December 27—Extending, until April 15th, 1914, time within which C.P.R. complete spurs for Moose Jaw Flour Mills, Limited, Moose Jaw, Sask., authorized under Order No. 20210.

21100—December 26—Approving location C.P.R. proposed station at Valor, on its Weyburn Westerly Branch, in N.E. ¼ Sec. 7-8-1, W. 3 M., Sask.

21101—December 26—Extending, until February 28th, 1914, time within which G.T.R. construct sidings for Otis-Fensom Elevator Co., Limited, at Hamilton, Ont., authorized under Order No. 20433.

21102—December 26—Relieving G.T.R. from providing further protection at crossing of highway east of Walkerville, Ont., known as Pellatt's Road crossing.

21103—December 23—Approving location G.T.P. Branch Lines station at Coalspur, at mileage 36.4, Alta. Coal Branch, Sec. 33-48-21, west 5th Mer., Alberta, station be erected in accordance with Co.'s Standard Structural Plan No. 1.

21104—December 22—Authorizing Algoma Eastern Ry. Co. to open for traffic its main line from mileage 79.80 to 80.80, and spur to station at Little Current from mileage 80.29 to 80.65, Ont.

21105—December 23—Suspending, for present, and pending investigation by Board, tariff C.R.C., No. E. 217, effective January 1st, 1914, increasing rates on pulpwood, in carloads, from points on the line of the Temiscouata Ry. to Riviere du Loup for local delivery.

21106—December 26—Authorizing Brandon Mun. Ry. Co. to operate its cars over crossing of C.N.R. on First St., Brandon, Man.; such cars to be flagged across by conductors of cars.

21107—December 29—Allowing C.N.R. to carry traffic over its railway between Avonlea and Gravelburg, Sask., a distance of 79 miles, until June 1st, 1914, subject to and upon condition that speed of trains over said line be limited to 20 miles an hour for first 26 miles and 15 miles for remaining 53 miles.

21108—December 27—Approving location Burrard Inlet Tunnel and Bridge Co.'s railway in city of Vancouver, from station 0.00 to station 130.03.6 on south shore of Burrard Inlet, B.C.

21109—December 27—Authorizing C.N.R. to construct across public road between Sec. 6-28-28, and Sec. 1-28-29, W. 3rd M., Sask., on its Alsask Southeasterly Line.

21110—December 27—Approving temporary diversion of G.T.R. Co.'s Seventeen Dist. Main Line tracks about 1 mile east of Merritton Station, Ont. 2. Approving plan showing superstructure of said temporary bridge to carry said diverted tracks over Welland Canal.

21111—December 29—Approving location C.P.R. station at Colborne, in Lot 32, Con. 1, Tp. Cramahe, Co. Northumberland, (East Riding), Ont., mileage 105.1 from Glen Tay.

21112—December 27—Authorizing Dominion Altantic Railway to open for traffic portion of grade revision of its line extending from a point on west side of St. George Street, Annapolis Royal, N.S., thence westerly to a point on west side of Allen's Creek, a distance of 2,790.5 feet; and use and operate bridge across Allen's Creek.

21113—December [illegible]—Authorizing C.P.R. to open for traffic double track from mileage 0 to 6, Medicine Hat Subdivision, Alberta.

21114—December 30—Authorizing C.P.R. to construct across highways at mileages 68.18, 69.44, 73.76, 165.95. 111.81, 112.88, and 115.05, Bassano Easterly Branch.

21115—December 29—Authorizing C.P.R. to construct spur for C. H. Richards, Saskatoon, Sask., subject to certain conditions.

21116—December 30—Authorizing Vancouver and Lulu Island Railway Company to construct branch from its railway at intersection of 3rd Avenue, Vancouver, thence along and across 3rd Avenue, and Granville Street for a distance of about 578 feet, to property of British Columbia Electric Railway Company, Limited, adjoining 3rd Avenue and Granville Street Bridge, and through said property to passenger and freight station proposed to be erected on said property, to be completed within 6 months from date of this Order, subject to conditions that Applicant do as little damage as possible and make full compensation to all persons interested for all damage done. 2. Also approving location of said passenger and freight station proposed to be erected on property of leased by British Columbia Electric Railway Company, Limited, in city of Vancouver.

21117—December 29—Amending Order No. 19256, dated May 13th, 1913, by substituting plans Nos. 55257 and 54122 for plan approved under said Order No. 19256.

21118—December 27—Rescinding Order No. 20941, dated December 3rd, 1913, in so far as it approved plan showing location Bassano Easterly Branch of Canadian Pacific Railway, from point in Sec. 22-26-23, W. 3 M., mileage 170, to point in Sec. 19-26-22, W. 3 M., mileage 173.

21119—December 29—Approving and authorizing clearances as shown on Canadian Pacific Railway plan showing minimum clearances of suspended signals in train sheds at Windsor Street Station, Montreal, Que.; provided men are kept off top and sides of cars while operating through said train sheds.

21120—December 29—Authorizing C.P.R. to reconstruct bridge No. 0.7 across Wellington Street, Sherbrooke, Que.

21121—December 29—Relieving C.N.R. of the speed restriction of 18 miles an hour over its Goose Lake Line, between Kindersley and Alsask, Province of Saskatchewan.

21122—December 30—Authorizing C.N.O.R. to open for traffic certain portions of its Toronto-Ottawa Line; authorizing it to use bridges on said portions; and limiting the speed of trains operated over said line.

21123—December 27—Authorizing C.N.R. to construct across Three (3) highways, namely:—1. between Sec. 11 and 10-28-29, W. 3 M.; 2. 31-27-28 and 6-28-28, W. 3 M.; and 3. Secs. 1 and 2-28-29, W. 3 M., Sask.

21124—December 29—Authorizing C.N.R. to construct spur for Huff Gravel Company, Limited, in River Lot 20, Penitentiary Grounds, Edmonton, Alta., and to cross Government Avenue with said spur.

21125—December 30—Authorizing C.N.R. temporarily, until July 1st, 1914, to carry traffic over Oakland Branch from mileage 42 to end of track, in province of Manitoba, distance of 12 miles; operation of trains over said line be limited to a speed not exceeding 12 miles an hour.

21126—December 29—Authorizing G.T.P.R. to construct main line across Government Road at mileage 397.4 Prince Rupert Easterly, in Sec. 9-11-5, Coast District, B.C.

21127—December 29—Suspending, for the present and pending investigation by Board, following tariffs:—C.P.R. Co.'s C.R.C. No. W. 1893, and Esquimalt and Nanaimo Ry. Co.'s C.R.C. No. 256.

21128—December 27—Suspending for present and pending investigation by Board, tariff C.R.C. No. 395, of Dominion Atlantic Railway Company.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

THE COQUITLAM-BUNTZEN HYDRO-ELECTRIC DEVELOPMENT

HARNESSING THE WATER POWERS OF COQUITLAM AND BUNTZEN LAKES, BRITISH COLUMBIA—NEW HYDRAULIC-FILL TYPE OF DAM AT COQUITLAM —WESTMINSTER WATER SUPPLY—POWER EXTENSIONS AT LAKE BUNTZEN

By G. R. G. CONWAY, M. Can. Soc. C.E., M. Inst. C.E.
Chief Engineer, B.C. Electric Railway Company, Limited

THE Coquitlam Lake water power development is owned and operated by the Vancouver Power Company, Limited, which is a subsidiary company of the British Columbia Electric Railway Company, Limited, a company operating a railway, light and power business in the districts surrounding the cities of Vancouver and New Westminster, and the Fraser Valley, and also the city of Victoria and district on Vancouver Island.

The main features of the original power development, which were put into operation in December, 1904, consisted of a scheme connecting Lake Coquitlam with a lake known as Lake Buntzen by means of a tunnel through a mountain range 4,000 ft. high separating the two lakes, which has an elevation of about 400 ft. above the North Arm of Burrard Inlet.

At the outlet of Lake Buntzen a concrete dam was built 54 ft. high and 301 ft. long. From this dam originally four penstock lines were carried down 1,800 ft. to the power house, which is situated on a rocky bluff at the edge of the tidal waters of the North Arm. The original plant consisted of four 3,000 h.p. Pelton wheels, having an effective head of about 395 ft., and four 1,500 kw. Westinghouse generators.

Fig. 1.—General View of Coquitlam Dam During Construction.

Watershed.—The available water supply is derived from the Coquitlam watershed, which has an area of 105

sq. mi. The upper part of the watershed rises to 8,000 ft., and is covered with perpetual snow. Over this watershed the annual precipitation for the last eleven years has averaged 155 in. The maximum year during that period was in 1906, when the precipitation was 190 in. The minimum year was in 1911, with a record of 132 in. The maximum monthly precipitation is during the month of November. The average precipitation for November for the past ten years amounts to 28 in.; the maximum recorded rainfall during that period for the month amounts to 37¼ in.; the minimum recorded is 10.62 in. The minimum monthly rainfall is in July, the average for the past ten years being 2½ in. In the original project, Lake Coquitlam, which has an area of about 2,000 acres, was raised 11 ft., or from El. 432 ft. above sea level to El. 443 ft. The lake was raised by means of a rock-filled timber crib dam 169½ ft. in length, which was designed as an overflow dam, having a spillway 113 ft. long. The area of the lake formed by the old dam was 2,328 acres, and with the growth of the demand for electric energy, it was decided that practically all of the water running off from the watershed could be conserved if a dam were built at the outlet of the lake sufficiently high to store an additional 60 ft. of water, or a total depth of about 71 ft. that might be drawn down. Careful observation of the run-off data showed that slightly in excess of 1,000 cu. ft. per sec. was the average run-off for the whole year. This run-off represented about 78 to 80% of the recorded precipitation at Coquitlam Lake, and represents an average water storage of electric energy of 220,000,000

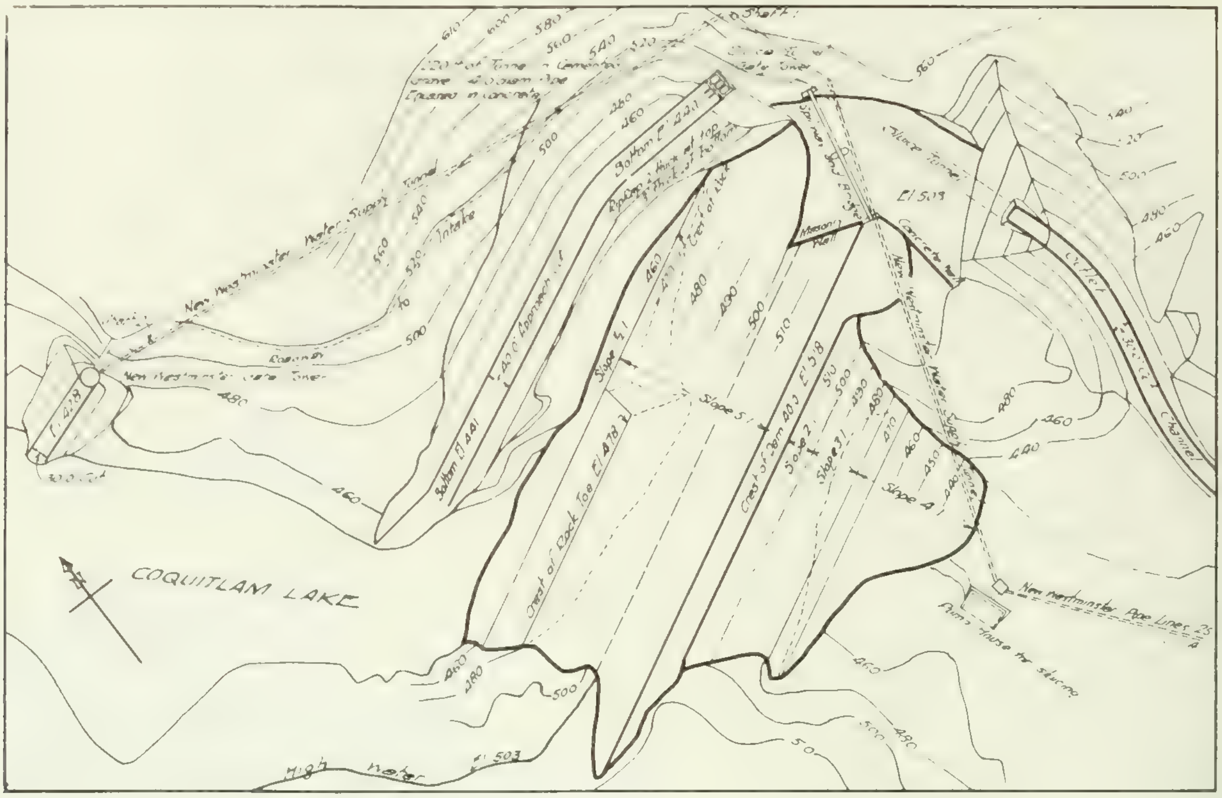


Fig. 2.—General Plan of the Coquitlam Dam, and Surrounding Development.

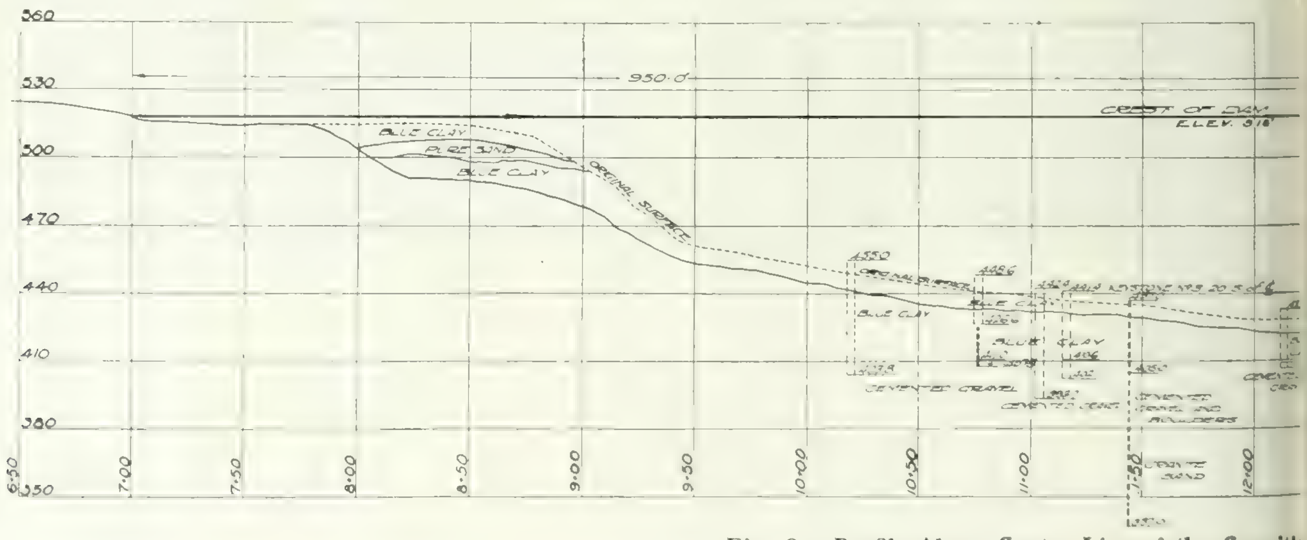
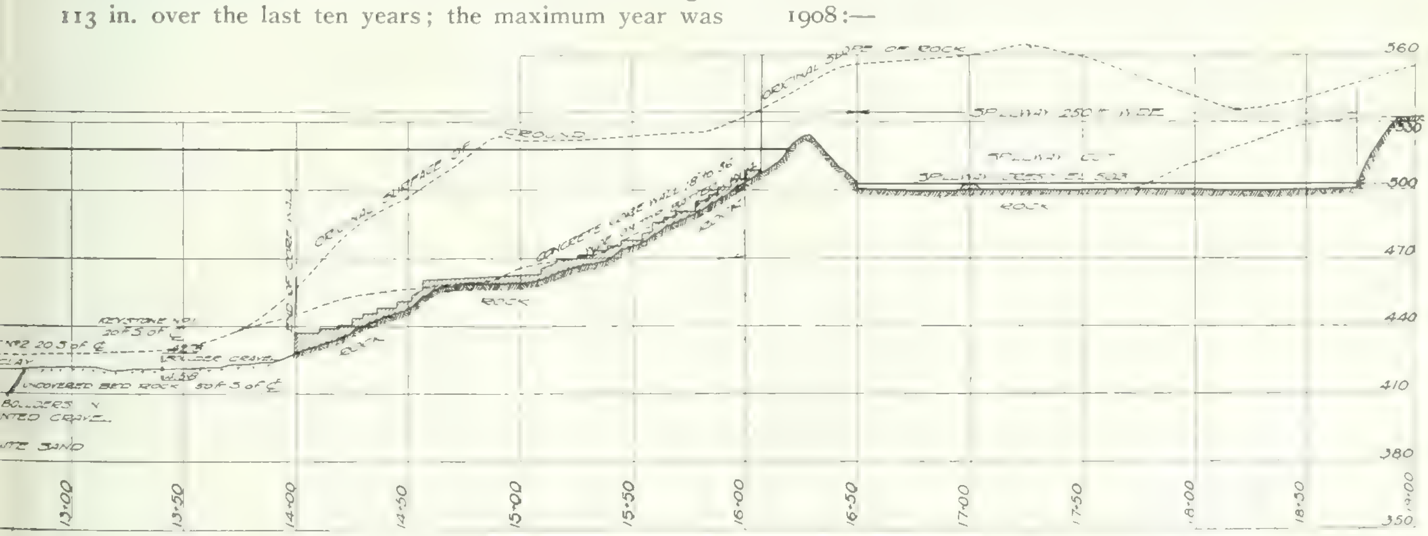


Fig. 3.—Profile Along Centre Line of the Coquitl

kilowatt-hours. To deal with this increased quantity of water it was necessary to enlarge the Coquitlam-Buntzen power tunnel, which originally had a cross-section of 81 sq. ft. and a capacity of 300 cu. ft. per sec., to 178 sq. ft. This work was completed in the spring of 1911, and the tunnel has now, when the lake is full, a maximum discharging capacity of 1,350 cu. ft. per sec. In addition to the water for Coquitlam Lake, Lake Buntzen, which has an area of 500 acres and a drainage of 7 sq. mi., has a considerable run-off. The rainfall at that lake averages 113 in. over the last ten years; the maximum year was 1906, when it was 137½ in., the minimum year 98½ in. 1911. The storage capacity of Lake Buntzen is 6,000 acre-feet.

The necessity of utilizing all the available water supply in Coquitlam Lake was due to the extraordinary growth which has taken place in the development of the City of Vancouver and surrounding districts during the last five years. The following figures represent the output of electric energy from the company's plants since 1908:—

Fig. 4.—Foundation Ready for Hydraulic Filling, Coquitlam Dam.



n, Vancouver Power Company, Limited.

1908-09	40,000,000	kilowatt-hours
1909-10	48,000,000	" "
1910-11	75,000,000	" "
1911-12	102,000,000	" "
1912-13	120,500,000	" "

It was therefore decided that the original plant which had been increased from time to time, bringing the total output up to 42,500 h.p., should, with the available storage in the Coquitlam Lake, be increased to a total of 83,000 h.p., so that the two plants could be operated satisfactorily as a peak load plant in conjunction with other plants contemplated by the company in the future.

Fig. 5.—Gate Tower at Diversion Tunnel, with Flash-boards for Temporary Water Storage.

New Dam.—A plan and profile of the new dam which is of the hydraulic-fill type with heavy rock toes, is shown in Figs. 2 and 3 respectively. The preliminary operations of building the dam were begun in the winter of 1908. Much exploration work was rendered necessary by opposition to the construction of the dam from various quarters, to determine the foundation conditions and also the location of rock for the purpose of driving a diversion tunnel for the floods. The result of the exploration showed rock in the east bank which dropped to an unknown depth one-third of the distance across the old river bed; abutting against this rock was a fine strata of blue and yellow impervious clay, making a perfect foundation for a dam of the hydraulic-fill type. The actual construction of the dam proper was not begun until March, 1912. The main dimensions of the new dam are as follows:—

Height of dam on centre line	99 feet
Extreme width of dam at base	655 "
Width at crest	40 "
Length of dam along crest, exclusive of spillway	950 "
Width of spillway	250 "
Elevation of spillway above sea level	503 "
Crest of dam above sea level	518 "
Slope of up-stream face	1 in 5
Slope of down-stream face	1 in 2 to 1 in 4
Original area of lake, old dam	2,328 acres
Area of lake at elevation 503 ft.	3,075 "
Storage capacity of lake above elevation 432 feet	192,100 acre-ft. or 8,369,000,000 cu. ft.
Storage capacity in electric energy at 78% efficiency	60,600,000 kw. hrs.

For the purpose of diverting the river and flood waters during the construction of the dam, a tunnel 490 ft. in length, having a clear width of 26 ft. with a height of 18½ ft. in the centre, was constructed on the east bank. This tunnel, which has its invert level at El. 435, was designed to carry 12,000 cu. ft. per sec. when the lake level was at El. 475, but the maximum quantity discharged through it did not amount during construction to more than 6,000 cu. ft. The maximum recorded flood over the old dam during the past ten years was 12,000 sec.-ft., or approximately 116 cu. ft. per sec. per sq. mi. of drainage area.

Gate House.—The gates for controlling the water through the diversion tunnel were placed in the concrete tower at the end of the approach channel. The bottom of the tower is at El. 455, spanning the tunnel entrance and supported on piers placed parallel to the floors in the tunnel. Girders were provided at the up-stream end of the piers for six temporary steel roller gates each 4 ft. 6 in. wide by 17 ft. high. These gates were controlled during the construction of the works by means of a gasoline hoist placed at El. 475 and arranged so that as the water rose in the lake they could also be operated at El. 508.

Upon the completion of the dam these gates were closed behind with a bulkhead of concrete filling up the whole space at the bottom of the tower, and forming a solid mass of concrete 26 ft. thick.

The tower, illustrated in Fig. 5, is rectangular in form, built up of three separate and independent compartments each 8 ft. by 11 ft. The main sluice gates are three in number, each five feet in diameter, faced with gun metal, and are designed to allow a certain quantity of water to pass down the river at any time for keeping

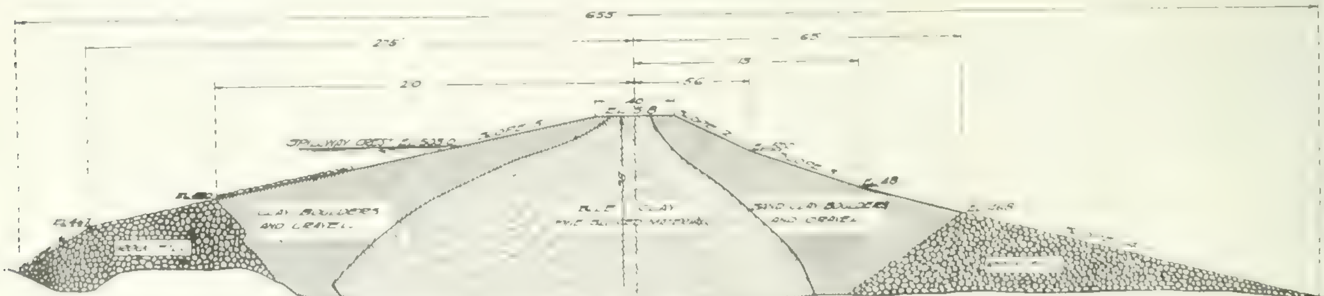


Fig. 6.—Coquitlam Dam, Maximum Cross-Section as Built.

it clean when required. These gates are operated at El. 513 within a gate house built at the top. The exterior openings to the three compartments are provided with auxiliary sluice gates made up of steel I-beams and timbers; but these will only be used when inspection of the main gates are necessary. Inclined racks are built against the front of these gates to protect them from water-logged timber and trash that might be drawn towards them when the gates are open.

In the construction of the works 1,150,000 cu. yds. of material were handled; this included the excavations for the approach channel to the diversion tunnel, and the outlet channel from the diversion tunnel and tunnel excavations.

The dam, as already mentioned, is of the hydraulic-fill type, the materials being sluiced by pumped water from borrow pits on the southwest and northeast banks of the river. Its cross-section is shown in Fig. 6.

Fig. 7.—A 70-ft. Trestle Over Spillway Cut, for Carrying Flume from N.E. Borrow Pit to the Dam.

The total quantity of material in the dam amounted to 544,710 cu. yds. In addition to this quantity about 40,000 yds. of material were sluiced in front of the old dam for the purpose of gaining additional storage during the construction of the work. Of the total quantity of material in the dam, 489,800 cu. yds. were sluiced from the borrow pits. In addition to this material there were 116,360 cu. yds. of heavy rock placed in position by hand and by cableways to form the rock-fill toes. The average quantity of material sluiced into the dam was 47,400 cu. yds. a month from October, 1912, to July, 1913, the greatest quantity being 77,700 cu. yds. during January, 1913; an average of 2,500 cu. yds. per day. The total number of days in which sluicing was carried on with two shifts of ten hours each was 296 days, included in which time were periods necessary for removing flumes.

The main flumes were laid on an average grade of 4%. These were carried on trestles of various heights reaching to a maximum of nearly 70 ft. One of these is illustrated in Fig. 7. The flumes were formed of two 12 x 1-in. planks in width, and 2 ft. 6 in. high, lined on the bottom with 6-in. hemlock blocks, a 1 x 6-in. plank being nailed inside along each side of the flume. The trestles supporting the flumes were formed of 6 x 6-in. posts, caps and stringers for the first deck, with 4 x 4-in. posts, 4 x 4-in. caps, and 6 x 6-in. stringers for the second deck. These trestles were placed 16 ft. apart, and very satisfactory results were obtained from the type of flume adopted. The lining of the blocks in the bottom of the flumes from the northeast borrow pit was renewed only once during the construction of the works, and the remainder required occasional patching only.

Ball bearing giants, 4 in. and 5½ in. in size, fitted and controlled by the Hendy deflector, were used under a pressure of about 80 lbs. per sq. in. at the nozzle. These delivered for sluicing operations 215,000,000 cu. ft. of water during the actual dam construction. The percentage of solids to water carried from the pits amounted to 6.14%, representing 5.36% of solid material as measured in place in the dam. For conveying the water to the monitors, 16-in. flange pipes in 17-ft. lengths were used. The labor costs of sluicing ranged in different months from 6 to 16 cents per cu. yd., depending upon the amount of work to be done in removing flumes.

The pumping plant consisted of two Dayton centrifugal 3-stage pumps with 10-in. suction, 8-in. discharge, working at 150 lbs. pressure, rated to deliver 4 cu. ft. per sec.; two Byron-Jackson, 3-stage, centrifugal pumps, 10-in. suction and 10-in. discharge, rated to deliver 7½ cu. ft. per sec.; one Worthington 3-stage centrifugal pump rated to discharge 4 cu. ft. These were driven by five electric motors having a combined capacity of 1,125 h.p.

Power was delivered to the dam for construction purposes at 34,000 volts and transformed down to the required voltage at the works.

Two electrically operated Lidgerwood cableways of 3-ton capacity were used for depositing the rock toes of the dam, one of 1,100 ft. span and the other 1,200 ft.

The clay from the borrow pits for the construction of the dam was a very finely stratified blue and yellow glacial clay mixed with a large proportion of gravel and heavy boulders. Samples taken from this clay in the pits showed it to have about 23 to 25% of moisture, and actual samples taken from the dam upon completion showed from 25 to 27%. The material forms the very finest clay concrete for the construction of the dam, and is absolutely impervious. Fig. 6 shows the approximate position in which the materials were placed as plotted for the monthly progress diagrams. The up-stream and down-stream slopes of the dam were very heavily rip-rapped with rock.

By reference to Figs. 6 and 8 it will be seen that the dam has been designed with unusually flat slopes and a

wide crest. This is due to the fact that the stability of the dam had to be such as to satisfy the sentimental objections of the population living below the dam, although these dimensions were entirely unnecessary from an engineering point of view.

The spillway, which is capable of discharging over three times the maximum recorded flood, was excavated on the east bank of the river in solid granite, about 90,000 cu. yds. of material being removed and deposited by the cableways to the rock toes. Over the spillway a steel bridge of two spans, each 125 ft. in length, has been constructed to form a continuation of the roadway over the dam to the Westminster intake tower.

Westminster Water Supply.—Lake Coquitlam has, since the year 1892, been utilized as the source of water supply for the City of New Westminster. A company called the Coquitlam Waterworks Company, formed in 1886, now owned by the Vancouver Power Company, sold to the City of New Westminster in the year 1889 certain rights in the waters of Coquitlam Lake for the purposes of the city supply, and the works were begun by the city soon afterwards. This supply was first drawn from Lake Coquitlam in the year 1892, from an intake which was situated on the west bank of the river near what was subsequently the site of the old crib dam. From this intake a 14-in. steel pipe main was carried to a distributing reservoir in the City of New Westminster. This main was sufficiently large to supply water for that city until 1912.

Fig. 8.—Coquitlam Dam and Spillway, Nearing Completion.

Under the agreement entered into between the Vancouver Power Company and the Department of the Interior of the Dominion Government the company undertook to carry out certain improvements for the protection of the Westminster water supply, and among other things that were agreed upon was the provision of the new intake tower situated 1,000 ft. north of the old intake on the east bank of the lake. From this intake tower a tunnel 1,940 ft. long was constructed, the greater part of its length, being in solid rock 4 ft. wide by 7 ft. high, with a concrete invert. In other portions where the tunnel passed through cemented gravels and clays, it was formed of 48-in. steel pipe backed with concrete. The intake tower is a heavy concrete tower which has its foundations on rock. The outlet of the tunnel is at El. 428, or 4 ft. lower than the lowest draw-off of the Coquitlam-Buntzen power tunnel, while the floor of the gate house on the top is at El. 518, corresponding to the crest level of the new dam. The intake tower is circular in plan, and has an inside diameter of 18 ft. top and bottom. The walls are 4½ ft. thick, from the bottom to El. 465, and then taper to 18 in. thick at El. 518. A concrete arch bridge connects the intake tower with the roadway on the shore. In the walls of the tower there are four 40-in. square openings fitted with cast iron gates, and cast iron screens on the inside, the exterior openings being protected with wrought iron screens. These openings are placed at El. 430, 451, 469 and 487, distributed around the outer wall of the tower. The copper screens are arranged so that they can be raised for cleaning purposes to a floor inside the tower placed at El. 508. In addition to the control of water from the exterior of the tower, a secondary control is obtained within the tower so that the water may be drawn off at any desired elevation. This intake consists of a standpipe 42 in. in internal diameter, built up in four separate sections, each section having conical seats on the upper and lower ends, and each section fitting to the one next below it. The bottom section rests on a special cast iron elbow set in the base of the tower. These intake pipe sections are guyed to 60-lb. rails placed on opposite sides of the pipe, and bracketed to the tower wall at frequent intervals. Lifting rods 1½ in. in diameter are attached diametrically opposite near the top of each pipe section. The intake is operated by hand by means of a special lifting gear which may be attached to any set of lifting rods. The openings into the intake pipe are at El. 433, 451, 473 and 481. To form the approach to the tower a channel was excavated within a cofferdam 20 ft. wide at the bottom with side slopes 1½ to 1, heavily rip-rapped with rock.

For the protection of the Westminster water supply the company carried out extensive clearing operations on the shores surrounding the lake, which were covered with a heavy growth of cedar and hemlock. For a distance of over three miles above the intake, the whole of the land to be flooded was cleared and the stumps sawn close to the ground. The clearing over this section was completely done to El. 508, and in the upper part of the lake the whole of the shores have been cleared to El. 480. The total area of land completely cleared amounts to approximately 750 acres.

This work proved enormously difficult, owing to the steep sides of the lake and the necessity of constructing rafts plated with steel for burning much of the debris. The cost of clearing has been upwards of $600,000. The lowest cost for clearing was about $350 an acre, while sections of the work in swamps where the timber was decayed and heavy, cost as much as $2,000 an acre.

The Coquitlam Lake water is of wonderful purity and is almost sterile. The following is a typical analysis of the water:—

Water Analysis—October 18, 1913.

(Parts per million.)

Physical Examination—

1. Turbidity	None
2. Reaction	Neutral
3. Smell	None
4. Taste	Good
5. Sediment	Slight
6. Color	30

Chemical Examination—

1.	Ammonia, free, expressed as nitrogen	.056
2.	Ammonia albumenoid, expressed as nitrogen	.07
3.	Nitrates, expressed as nitrogen	.06
4.	Nitrites	None
5.	Chlorine	3.24
6.	Hardness, total, expressed as CaO	2.20
7.	Hardness, permanent	1.40
8.	Hardness, temporary	.80
9.	Oxygen consumed, 4 hours at 37° C.	2.7
10.	Oxygen consumed, 3 minutes at 37° C.	.4
11.	Solids, total	18
12.	Solids, volatile	8
13.	Solids, fixed	10
14.	Poisonous metals	None

Microscopic Examination—
Vegetable fibres and crystalline matter.

Biological Examination—

Number of bacteria per c.c.	30.
Presumptive test for color bacilli	Negative

Samples of water have been carefully analyzed fortnightly during the past four years, and the number of bacteria per c.c. has varied from 15 to 100, but has averaged throughout the whole period of the work about 40 or 50 per c.c. In spite of the fact that over 800 men were employed upon the works, of whom nearly 600 were employed on lake clearing alone during some months, no pathogenic organisms were discovered at any time, a result due to the very careful sanitary precautions which were taken in connection with the construction of the works.

Power Plant No. 2, Lake Buntzen.—Owing to the fact that suitable foundations could not be obtained for extending the existing power house of a sufficient size to contain the new units, a new site was decided upon about 2,000 feet south of the existing power house No. 1, and there a new and independent plant has been constructed. The essential features of this new plant are shown in Fig. 9.

Water is obtained from Lake Buntzen through a concrete-lined tunnel 14 ft. 8 ins. internal diameter, and about 1,800 ft. long, driven through solid rock.

At the upper end of the tunnel three 6½-ft. Doble intake valves are provided, which are operated by oil pressure.

In order that better speed regulation of the machines may be obtained, and that the effects of water in the pipe lines due to sudden changes of load may be reduced, a surge tank is provided at the tunnel portal. This surge tank is 30 ft. in diameter and about 90 ft. high, and is built of riveted steel plates.

The pipe lines, of which there are three, are connected to the surge tank by means of reinforced plates. The upper ends of the pipes project into the surge tank, and are each provided with a bell-mouth, thus minimizing entrance losses. The pipes are 8 ft. 6 in. diameter and ½ in. thick at their upper ends, and taper to 7 ft. diameter at the power house, where the thickness is 1⅛ in. About 200 ft. from the power house the pipe lines pass into tunnels driven through rock, which is badly fissured. The slopes range from 28 to 53 degrees. A short distance below the surge tank, a Doble venturi butterfly valve is provided on each pipe line.

The power house building (Fig. 10) is of reinforced concrete construction, and is founded throughout on solid rock. On the main floor, 5 ft. above high-water mark, three hydro-electric units of a combined capacity of 40,500 h.p. have been installed. Each unit consists of one Dick Kerr 8,900-k.v.a., 3-phase, 60-cycle alternator, generating current at 2,200 volts, direct-driven at a speed of 200 r.p.m. by four Pelton-Doble water-wheels of the impulse type, the combined capacity of which is 13,500 h.p. The rotor of the alternator and the four water-wheels are all pressed onto a hollow nickel steel shaft 51 ft. 3 ins. long, and operated in one piece.

At the power house each pipe line divides into four branches, each branch supplying water to one wheel of the unit. On each branch a Doble hydraulically operated gate valve is provided, which controls the admission of water to two needle nozzles, which direct the water to the buckets of each wheel.

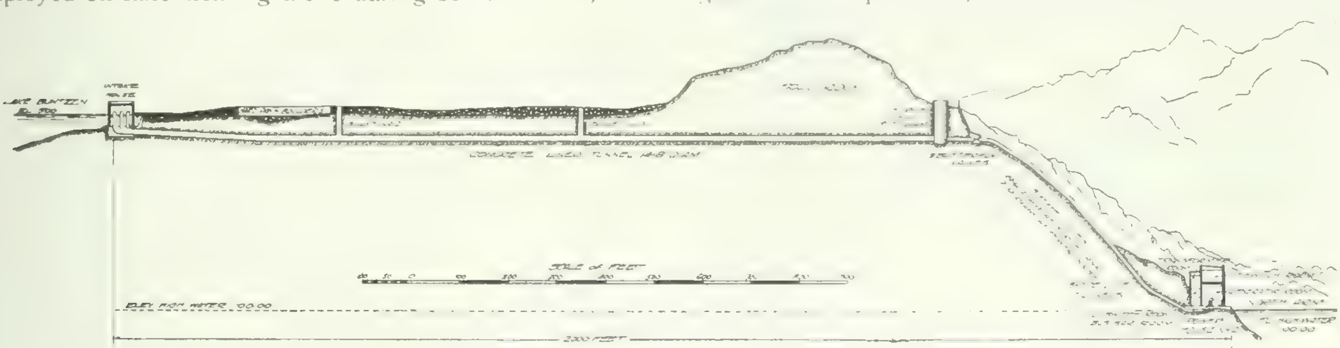


Fig. 9.—Lake Buntzen Power Development, Profile of Tunnel, Penstocks, Etc., of Plant No. 2.

The speed regulation of each unit is controlled by a Lombard governor, and two improved relief nozzles, which are controlled by the governor, are provided on each unit.

For excitation purposes, three 300-h.p. exciter units are provided. Each exciter unit is composed of a Dick Kerr induction motor generator set, direct-driven by two Pelton-Doble water-wheels mounted on the end of the shaft. The speed of the exciters is 600 r.p.m.

The excitation voltage is 250, and the voltage regulation on the A.C. bus bars is controlled by Tirrell regulators.

Owing to the great size and weight of some parts of the units, two 50-ton electrically operated travelling cranes are provided. These cranes control the entire length of the main generator room.

Immediately above the generator room is located the high-tension switch room, which also contains lightning arresters, etc. The high-tension switches are of the C.G.E. K-15 type, and are suitable for 60,000 volts. The lightning arresters are of the 4-tank electrolytic type.

To the rear of the generator room and above the bus bar compartments is the low-tension switch room; the low-tension switches are all of the C.G.E. H-6 type.

The transformer room is located immediately above the low-tension switch room. The transformer equipment consists of four banks of three 3,000-kw. single-phase, 60-cycle, oil-insulated, water-cooled transformers, by means of which the voltage will be raised from 2,200 to 34,000. At a later date the transformers will be "Y" connected, thereby increasing the voltage to 60,000. One 25-ton electrically operated travelling crane which travels the entire length of the transformer room is provided, together with the necessary oil tanks, oil filters and pumps. Current is fed to the lines through the above-mentioned K-15 high-tension switches.

Fig. 10.—Lake Buntzen Power House, No. 2.

HUGE DRY DOCKS.

If New York is not to be at a serious disadvantage as compared with the ports of Quebec and Boston, it must provide its own dry dock for the accommodation of the largest ocean liners. Both of the two ports mentioned are building dry docks capable of taking in ships of 1,000 ft. in length. It is interesting to learn, says the "Daily Telegraph," that the New York Dock Commission is planning to build a dock of this size at South Brooklyn. The dry dock to be built at South Boston is to cost $3,000,000, and a contract has been entered into by which the International Marine, the Cunard and the Hamburg-American lines will pay $50,000 a year for 20 years for its use. The announcement of the intention of the Nova Scotia Government to erect at Halifax a huge dry dock, one capable of receiving the largest merchant vessels and warships afloat, or, as it is stated, likely to be afloat, is certainly indicative of what the expectations of the business of the port are. It may be added that the large graving dock which the United States Navy Department is building at Pearl Harbor will be finished as originally planned. The chief difficulty in constructing the dock, which has now been overcome, is the shifting of the sand bottom.

THE TESTING OF BITUMINOUS MATERIALS FOR ROAD AND STREET CONSTRUCTION.

ONE of the papers presented at the 10th annual convention (Philadelphia, Dec. 9 to 12, 1913) of the American Road Builders' Association dealt chiefly with the testing of bituminous materials to be used in the construction, maintenance and repair of roads and streets. It outlined clearly the fundamental principles upon which such tests are based, and brought out the importance of the relation of these tests to paving specifications. The paper was read by Mr. Prevost Hubbard, of the Institute of Industrial Research, Washington, to the "Construction" division of the convention. What follows here constitutes an abstract of Mr. Hubbard's remarks. The reader is also referred to a discussion of the paper by Mr. Francis P. Smith, of Dow and Smith, chemical engineers, New York, which appears on another page of this issue.

For reasons that are not clearly apparent, the fundamentals of testing, in so far as they relate to the practical utilization of tests, have in many cases been overlooked by testing engineers and chemists in connection with bituminous road and paving materials. Disregard of these principles has undoubtedly created more confusion and misunderstanding on the part of highway engineers and contractors than any other one cause.

As applied to materials of construction, tests of both chemical and physical properties serve two main purposes. (1) As a matter of investigation, they constitute a record of the characteristics of the material examined. (2) When considered in connection with the behavior of a material in use, they serve as a guide for the selection of such material for future use.

In the matter of investigation it is often highly desirable that the greatest possible number and varieties of tests be applied to a material of construction, as by this means the most complete record of its characteristics are obtained. After considerable data of this sort has been secured on many lots of the same material, it is not as a rule necessary to make use of all of these tests in selecting such material for future use. Certain inherent and peculiar characteristics as determined by tests are, however, of value in the matter of selection, and such characteristics, when governed by quantitative limits, are made the basis of specifications for that material.

The ultimate utilization of tests for the purpose of selecting material for a given use makes it necessary that (1) the test limits adopted shall specifically define the material, and (2) that the material thus defined shall have previously proved satisfactory for that particular use.

For some classes of material these points are not difficult to cover. In the case of bituminous materials, however, the matter is complicated by the numerous varieties or types of bitumen in common use, and the overlapping characteristics of various grades of these different types. The interpretation of tests in general is therefore no simple matter, and numerous misconceptions of the value of certain tests are prevalent. Standards of more or less established test values have been thrown into question by the introduction of new types of bituminous materials which, while similar to or identical in many respects with other better known materials, yet differ from them materially in certain physical or chemical properties. This has made it necessary to either modify old standards or to create new standards to be used specifically for the new materials introduced. It is the

author's opinion that the latter method is in general to be preferred for reasons that will appear later.

The individual tests required by specifications for bituminous road and paving materials may serve one or more of the three following purposes: (1) They may directly indicate the suitability for a given use, of the material specified. (2) They may serve as a means of identifying the source of a material or even the material itself. (3) They may serve to control uniformity in the preparation or manufacture of a material.

The first of these purposes is undoubtedly the most important and is usually the only one considered by the lay mind. In the case of bituminous materials, this purpose is only partly accomplished by a comparatively few tests. As examples may be mentioned tests of constituency, such as the penetration test, the float test and the test for viscosity. Such tests can only be of maximum value, however, when applied to a specific type of bituminous material and when considered in connection with other tests, which, by themselves, may not directly indicate suitability. Thus, for a certain type of bituminous concrete pavement the proper penetration limits at 25° C. for a California asphalt may lie between 7.0 and 9.0 mm., while the proper penetration limits for a fluxed Bermudez asphalt to be used in exactly the same type of pavement and under the same conditions may be entirely different, say from 14.0 to 16.0 mm. It is evident that to attempt to cover the penetration limits for both materials under one specification would be useless. In the first place, such test limits as 7.0 to 16.0 mm. are so wide as to insure but little uniformity in different lots of the same materials; and, in the second place, an entirely unsuitable material of one class might be supplied under the maximum test limit of the other class. The fallacy of blanket specifications, which have already been advocated to a considerable extent, is thus easily demonstrated.

If a penetration test is essential under the conditions just mentioned, it is apparent that recourse must be had to separate type specifications; and if this is so the specifications must contain either tests or test limits which will describe certain peculiarities of the type specified, that are not common to other types. In many cases this cannot be done by means of a single test and two or more such tests will be required.

This brings us to a consideration of the second purpose previously mentioned, i.e., the use of tests as a means of identification. There are a number of such tests, among which may be mentioned specific gravity, melting point, solubility in carbon disulphide, fixed carbon, etc. So far as the usual test records are concerned, the specific gravity of a bituminous road or paving material is one of the most important characteristics used to determine its identity, and this is particularly true if its specific gravity is considered in connection with the consistency of the material and sometimes its solubility in carbon disulphide. Thus a bituminous material with a specific gravity of 0.99 and penetration of 7.0 mm., at 25° C. must be a blown product. Fluid consistency and high specific gravity, say 1.25, in a tar serves to identify it as a coal tar, and the identification is strengthened if its solubility in carbon disulphide is low, say 75 per cent. Numerous other examples of a similar nature might be cited and a treatise might be written upon the value of tests by themselves and in relation to other tests as a means of identifying bituminous materials.

High fixed carbon in most asphalt cements produced from Mexican petroleum is a distinguishing characteristic. Relatively low fixed carbon in good asphalt cements of the same consistency produced from California petroleums serve to differentiate them from the Mexican products. Here, again, the necessity or desirability of different test limits are apparent, for if the amount of fixed carbon yielded by a California asphalt cement was as high as the 16 per cent. often found in Mexican asphalt cements, indications would point very strongly to injury of the former due to excessive temperatures having been employed in the process of manufacture.

This leads us into the third purpose for which tests may be made to serve; control of uniformity in the preparation or manufacture of a material. Among such tests may be mentioned those for determining flash point, loss by volatilization, distillation, solubility in given grades of paraffin naphthas and solubility in carbon tetrachlorides. Practically all of the other tests previously enumerated may also be made to serve this end. No one by itself will, however, necessarily accomplish this purpose, no matter how close the test limits are drawn. This is mainly due to the fact that products of innumerably varied and complex characteristics may be produced from a given crude material by modifying the methods of manufacture.

Thus, by direct distillation of a given crude petroleum, an asphalt cement of 10.0 mm. penetration can perhaps only be produced by the removal of a considerable amount of distillate and the application of comparatively high temperatures. If distillation is discontinued in an intermediate stage, however, and the blowing process employed, an asphalt cement of the same penetration may be produced with the removal of much less distillate and the application of a lower maximum temperature. In the second case, the resulting product, while of the same consistency as the first, may have a lower specific gravity, a higher melting point, a greater penetration at low temperature, and a less penetration at high temperature. Other properties such as fixed carbon, naphtha, soluble bitumen, loss by volatilization, etc., may also be different. In such cases, control or assurance of uniformity in different lots of material must depend upon a number of tests, the interrelation of which is clearly understood, and for which suitable limits are specified.

In the preparation or interpretation of any specifications for bituminous road or paving materials, an appreciation of the interrelation of tests and test limits is as necessary as an understanding of the individual significance of the tests themselves, and yet those who should be most familiar with such matters often fail to consider the possible relations which a given test may bear to others with which it is associated in specifications. The interrelation of tests and test limits is something which the layman may not readily comprehend, and this has often resulted in his innocent acceptance and enforcement of unjustly discriminative specifications prepared or suggested by those who have an object to attain.

In the author's opinion, discriminative tests and specifications are perfectly proper and often desirable, if used in the right manner. They are, in fact, necessary to use, unless a more or less valueless blanket specification is adopted. When so used, however, their significance should be clearly apparent and they should not be put forward as open specifications.

When a given type of bituminous material has a single characteristic property which distinguishes it from other types, test limitations of this property may be so drawn as to make a specification discriminative. The status of such specifications is not usually difficult to ascertain. Discrimination is, however, sometimes secured by the use of a combination of two or more test limita-

tions, the significance of which is only apparent under the close scrutiny of one who has an intimate and comprehensive knowledge of all types of bituminous materials. Specifications of this class may, as a whole, absolutely eliminate competition, although no single clause in the specifications could be criticized from this standpoint.

If competition is eliminated by a single specification, as is sometimes advisable or even necessary, in order to insure a satisfactory product, it may often be restored by the use of two or more specifications which will serve as alternatives. When this is done, two or more types of bituminous materials will be specified, which are of equivalent value in so far as their suitability for a given use is concerned. Thus while different test limitations and sometimes different properties are covered by the different specifications, each particular combination of test limitations and properties, constituting a given specification, will be considered as equivalents.

From the foregoing discussion, it must be evident that the preparation of specifications for bituminous road and paving materials is often a complicated matter and should only be undertaken by one who has thoroughly familiarized himself with the origin and manufacture or preparation of all types of bituminous materials as well as with their physical and chemical characteristics. It is the author's experience that comparatively few highway engineers in this country are sufficiently acquainted with these materials to warrant them in preparing such specifications. Many who have attempted the task have failed because of lack of accurate information which has led them to combine and make use of portions of specifications prepared by others. Such combinations have most often proved utter failures, some of which are ludicrous, inasmuch as they have actually defeated the object for which they were presumably drawn. Others have been impossible because of the fact that certain clauses or test limitations prescribed were incompatible.

In this connection it may be said that while the average highway engineer will not find it practicable or even necessary to also become a highway chemist, he should nevertheless possess as a part of his practical working equipment some knowledge of the chemical and physical properties of bituminous materials and methods of testing them. A lamentable lack of such information is apparent in many highway engineers who, in other branches of their profession, are thoroughly capable and efficient. Opportunities for obtaining instruction along this line are now being offered by at least one of our universities, and many engineers should find that the comparatively short time required for this purpose could not be spent to better advantage.

One other point may be mentioned regarding the preparation of specifications which is directly connected with test limitations, and this is the matter of allowable variations in results which may be looked for from different chemists and different laboratories. In the first place it should be remembered that at the present time there are comparatively few standard methods for making tests which have been generally adopted. Variations in results are frequently attributable to variations in methods of testing. It is, therefore, good practice to include in, or as a part of specifications, descriptions of the methods to be employed in testing. This is especially true where specifications are to be widely used.

Besides the above mentioned cause, a certain variation in results may be expected from what is termed the personal question. Thus, no matter how clearly defined a method may be nor how conscientiously followed, it is the exception rather than the rule when two operators working on samples of the same material obtain exactly the same results. In fact, a single expert operator will seldom check himself exactly, although his results may be identical in so far as their practical application is concerned. Moreover, it should be realized that in substance as complex in character as are bituminous materials, however carefully prepared or manufactured, there is apt to be some variation in samples of the same batch whether taken from the same still, tank, kettle, barrel or even from the same sample can.

Just what the allowable variation in results should be when all of these conditions are taken into consideration, is a lengthy matter to discuss. It is certainly not the same for all tests, nor even for the same test applied to different classes or grades of material. Thus in the ordinary volatilization test a variation of 1 per cent. in results obtained upon a material losing 15 or 20 per cent. would be perfectly reasonable, while in a material losing 2 per cent. it would be an inexcusable variation. Owing to lack of time, the author does not consider it advisable to attempt a detailed discussion of this subject in the present paper, but suggests it is a topic for consideration.

In conclusion, the author wishes to state that while this paper may appear to deal with specifications in general more than with the actual testing of materials, it should be remembered that specifications are, in effect, definitions, and that from a broad standpoint definitions are themselves fundamental tests.

TRENT VALLEY FOREST RESERVE.

The Commission of Conservation is recommending that the 2,000 square miles of land in the Trent Canal watershed be set aside by either the Dominion or Provincial Governments as a forest reserve. Such a protective measure would under the peculiar circumstances, seem to be well advised. The water supply for the Trent Canal and Kawartha Lakes is obtained from the watershed mainly, and would be seriously impaired if the area in question were denuded of the remaining timber. Since the Dominion Government in 1905 obtained control of the water rights, much valuable work in damming up the back lakes has been done, with the result that the flow of water for power purposes north of Peterborough has enlarged most satisfactorily. The Dominion has spent over ten millions already on the Trent Canal, and by the time the extensions to Georgian Bay and Lake Ontario are completed it will have spent several millions more. And further, there are cogent reasons beyond the water-conservation interest to support the commission's recommendation. Half of the area is now unpatented, or in possession of the Crown. Only a tenth of the land can be farmed, and the farming at the best is so poor as to be quite unprofitable. Less than 700 acres of a million acres of forest is untouched virgin area. Under the provincial order-in-Council of 1905, conveying to the Dominion the water control, the right to buy land along the lakes and water courses at 50 cents an acre was granted the Dominion Government, but only two thousand acres were bought. It seems obvious that the best interests of the district, as well as the requirements of a wise conservation policy, would be served by making the areas in question a reserve for afforestation purposes

The production of coal in Italy in 1912 was 663,812 metric tons, of which 660,491 tons are classed as lignite. Imports were 10,057,228 tons; exports, 26,288 tons. The coke made —largely from imported coal—was 1,223,902 tons; briquettes, 874,365 tons.

DISCUSSION ON MR. PREVOST HUBBARD'S PAPER, "THE TESTING OF MATERIALS FOR ROAD AND STREET CONSTRUCTION."

By Francis P. Smith.

WHILE the speaker agrees with much that Mr. Hubbard has said, he does not consider that his objections to the so-called blanket type specifications are valid, more especially with respect to asphalts. The asphalt paving industry is by no means a new one. For upwards of forty years pavements and roadways of this type have been in use in this country. The speaker has for eighteen years been closely identified with this industry, and during that period has had charge of the mining and refining of asphalts and the laying of bituminous pavements of all kinds, and he, therefore, believes that he is qualified to judge, and justified in stating that the requirements of an asphalt for paving purposes are well understood and are comparatively simple and have nothing to do with the sources of the material. For specification purposes he considers that so-called identification tests are unnecessary.

The function of an asphalt cement or asphalt binder is to cement together the particles of the mineral aggregate which forms the roadway. In order to do this it must be possessed of sufficient cementitiousness or binding value. If it fails in this, it is useless as a cementing material. It must be sufficiently pure; i.e., contain sufficient bituminous binding material, to make it available for use. It must be of such a consistency that it can be properly applied to the mineral aggregate in such a way as to thoroughly coat each particle of it. It must not be too susceptible to changes in temperature; i.e., become too hard in winter or too soft in summer. It must not harden too rapidly when heated in the melting kettles and when exposed to the elements it must maintain its original properties for a sufficient length of time to give satisfactory service in the pavement or roadway. All of these properties are determinable by well known tests, and these tests must be met by all asphalts before they can be considered suitable for paving or road making use. It is true that different asphalts vary in their properties. Some are purer than others; some are more susceptible to changes in temperature or to prolonged heating, and some have higher cementing value than others. Experience has shown that a suitable asphalt for paving purposes need not possess all of these qualities in the highest degree, but sufficiently so for practical purposes. From past experience, however, it is perfectly possible to clearly define minimum limits which all asphalts must pass in order to be accepted with safety for paving work. Having done this, you have established the ideal specification of the blanket type which calls for all the necessary qualities and does not differentiate as to source, but as to quality only, and is not of excessive length. This fulfils the first purpose of a specification for bituminous road and paving materials as defined by Mr. Hubbard. Except in special cases, just why a specification should state at great length a number of tests for identifying the material, as stated by Mr. Hubbard to be the second purpose, the speaker fails to see. Anyone really competent to test bituminous materials for paving or roadmaking purposes can identify them just as easily without a specification as with one and certainly the contractor does not require this information to enable him to bid intelligently.

As to securing uniformity in the preparation or manufacture of a material, it would seem to be a simple task to insert a clause in a blanket type specification stating the maximum permissible variation in different shipments of the same class of material. To further insure that one manufacturer shall not adulterate or lower the quality of his material in any respect or respects so that it will **just** meet the minimum requirements of the specification, it may be required that all shipments of material shall be fully equal to the established standard and recognized quality of that particular brand.

Mr. Hubbard uses the variations in desirable consistency of different asphalts as an argument against blanket type specifications. Assuming that the wide variations which he cites are altogether normal, these are by no means wholly dependent upon the source of the asphalt. The considerations which affect desirable consistency or penetration are:—

1. Purity.
2. Susceptibility to changes in temperature.
3. Character of mineral aggregate.
4. Climatic and traffic conditions.

As to purity, the fluxed Bermudez which he cites contains about 96 per cent. of bitumen, the California about 100 per cent. of bitumen. There is too little difference in this respect to afford an excuse for separate specifications.

As to susceptibility to changes in temperature, the California is much more affected by temperatures up to 140° F.; i.e., softens more readily but, on the other hand, loses less when heated to 325° F.

The character and grading of the mineral aggregate, however, have as great an influence on the desirable penetration as the susceptibility of the asphalt to temperature changes.

The climatic and traffic conditions for any one particular piece of work will be the same in each case and may, therefore, be dismissed from consideration.

Until the material is actually assembled, however, it is impossible to state with certainty just what will be the proper penetration or consistency of the asphalt cement or binder, as it is impossible in most cases to draw a specification which will call for a mineral aggregate possessing a predetermined and definite degree of stability, and upon this the desirable consistency of an asphalt cement or binder largely depends. This consistency is something which the trained and experienced engineer can and should determine while the work is in progress. While this argument applies more forcibly perhaps to sheet asphalt pavements than to asphalt macadam, it is neverthelesse true of both types of construction and may be readily met by a clause in the blanket type specifications to the effect that the exact degree of penetration or consistency within the limits established by the specifications shall be determined by the engineer in charge, depending upon the kind of materials used and the traffic upon the roadway to be paved.

On the other hand, let us assume that a separate specification is to be prepared for each kind of asphalt. Those commonly in use are prepared by refining or fluxing, or both, Gilsonite or crude asphaltic material obtained from California, Cuba, Mexico, Texas, Trinidad and Venezuela. All of these differ essentially in purity and susceptibility to changes in temperature, and from the standpoint of consistency or penetration should, therefore, according to Mr. Hubbard, be considered separately. This would make seven separate specifications. In the case of Gilsonite, the character of

an asphalt cement or binder made from it would depend entirely on the kind of flux used with it, so that Gilsonite products alone might require two or more specifications. The same is true from the road binder standpoint of Trinidad, Cuban and Bermudez, while with California and Mexican asphalts the method of distillation used greatly affects the character of the product. In fact, the New York City paving specifications call for a special type of California asphalt much less ductile and susceptible to temperature changes than the standard California paving asphalt which has been successfully used for many years throughout the United States and is exclusively used on the Pacific Coast. Again, what is to hinder any manufacturer from combining two or more of these asphalts, as has been successfully done in many cases? To carry the separate specification idea, therefore, to a logical conclusion would involve the writing of an encyclopedia which would need constant revision and to separate the materials into two or three classes would be a poor compromise, leading to invidious distinctions, in many cases perhaps even to unfair discrimination, as it has done in the past. Such a compromise would, in the speaker's judgment and experience, be far worse than anything which has been alleged against the blanket type of specification.

In the early days of the paving industry closed specifications and high prices were the rule. As knowledge and experience in the paving industry have been acquired by engineers, closed specifications have become more and more rare and under proper blanket type specifications price has declined and quality has been maintained. The type brand of specifications were tried and abandoned as too cumbersome and the speaker freely admits that some years ago he advocated and drew a number of such specifications, but later became convinced that they were unnecessary and cumbersome and so abandoned them.

The Fixed Carbon Test.—With regard to the fixed carbon test,* the speaker considered that this is solely an identification test and therefore has no place in a specification unless it is desired to call for a particular kind or type of asphalt. This, as Mr. Hubbard states, may be perfectly proper in certain instances, but not in a specification where open competition is desired.

Many excellent pavements have been laid with California asphalt containing 16 per cent. and even 17 per cent. of fixed carbon, and it may, therefore, be considered at least doubtful whether the presence of this amount of fixed carbon in California asphalt is a sign that it has been injured in the process of manufacture.

The specific gravity test is undoubtedly of value as an identification test, but it is perfectly possible to recognize a blown asphalt without having recourse to this test, as, for instance, by the use of the ductility test. It is also questionable whether a certain amount of blowing is not the reverse of injurious so long as the ductility or cementing value is not reduced too greatly. Air blowing during distillation reduces susceptibility to changes in temperature and within limits and for certain purposes this is highly desirable.

A word with regard to the paraffine test.† The speaker believes that it has been conclusively proven that the presence of paraffine scale per se does not necessarily injure asphalt for paving purposes up to, say, 10 per cent., and possibly beyond that. The advocates of this test have recently taken the position that it is valuable as indicating the presence of an undesirable amount of paraffine hydro carbons in an asphalt, oils consisting largely of paraffine hydro carbons being recognized as unsuitable for the production of asphalt. To dispose of this claim it would seem to be only necessary to cite the case of many old and excellent pavements laid with Trinidad and other asphalts which contained over 25 per cent. of a flux composed almost wholly of paraffine hydro carbons. If 25 per cent. of paraffine hydro carbons is not injurious, where is the line to be drawn? It seems only reasonable to relegate this test to the class in which it really belongs, viz., the identification class, and rely on tests measuring the essential qualities of an asphalt when it comes to determining its fitness as a paving or road making material.

With regard to the ductility test, this has frequently been criticized by those who apparently do not understand its true scope or function. It has been claimed that the most ductile materials at ordinary temperatures, say 77° F., are those which are least ductile at low temperatures. This is not true. Great care must be taken in making ductility tests at low temperatures, otherwise the briquette will crack and no ductility will be reported. What is true is that the most highly ductile materials lose relatively a greater proportion of their ductility at low temperatures than do low ductile materials, but it must be remembered that even at 77° F. the latter class have practically no ductility to speak of. In the speaker's experience and in that of many others, the ductility test more nearly measures the cementing value of an asphalt than any other test known, and it is in that that its chief value lies. In this connection I will quote some remarks recently made by Mr. C. N. Forrest, of the Barber Asphalt Paving Comany, concerning the ductility test:—

"There is another fallacy in connection with the ductility test. It has been asked why should not the material be ductile at thirty-two degrees Fahrenheit, the supposition being that when a pavement expands and contracts, the resistance of the asphalt, under those circumstances, is dependent more or less on ductility, but the ductility test as performed according to the general way of doing it, as we know it, is a measure of the cementitious value. To produce a material that is ductile at thirty-two degrees Fahrenheit is to produce a short material; that is, if it is ductile at 32, it is not ductile at 77, and that would be done by the same method as increasing the toughness—by using a blown oil.

"The ductility test has nothing whatever to do with the capacity of the asphalt to give and take with the expansion and contraction. As a matter of fact, the asphalts which are rubbery and show some resistance to impact and show some ductility at a low temperature, will seldom show enough for sheet asphalt. They will crack in cold weather, although they are rubbery and show resistance to temperature changes."

As to variations in results as mentioned by Mr. Hubbard, the writer has often seen determinations reported in hundredths of a per cent. when the method employed was not accurate within tenths of a per cent. In similar cases he has also known material to be rejected because it exceeded the specification limits by two-tenths of a per cent. where the method used was not accurate within one-half of one per cent.

In conclusion, the speaker wishes to most heartily concur in Mr. Hubbard's statement as to the necessity

*See The Canadian Engineer, Vol. 25, pp. 703, 738, 780, 801, 808, and 872.

†See The Canadian Engineer, Vol. 25, p. 838.

for an understanding of the individual significance of the various tests and the relations of the different tests to each other. Without this knowledge the preparation of proper specifications and the interpretation of them is impossible.

INFLUENCE OF THE POSITION OF CROWN HINGE ON THE WEIGHT AND DEFLECTION OF A THREE-HINGED SPANDREL-BRACED ARCH.

THE form of three-hinged spandrel arch most frequently used in bridges is that in which the crown hinge is placed in the lower chord. Often, however, the crown hinge is located midway between the upper and lower chords, or in the upper chord, the weight and deflection of each member varying with different positions of the hinge. Just what the variation is in each case is given in a brief form by Messrs. M. A. Beltaire and R. W. Parkhurst in *The Cornell Civil Engineer* for December, 1913. Their results are from a series of investigations to compare the weights and deflections of three-hinged metallic arches as influenced by the shifting of the crown hinge from its ordinary position in the lower chord, to a position intermediate between the chords, and finally to the upper chord. These three positions are designated in the following as Case B, Case I and Case T respectively.

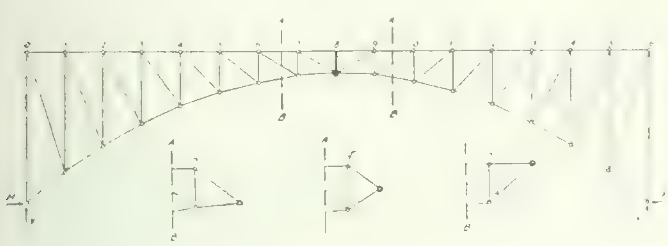


Fig. 1.—Three-Hinged Arch Bridge.

In conducting these investigations it was not thought necessary to work out a new design of a three-hinged metallic arch, a sufficient field for investigation being furnished by a study of the design of the Niagara spandrel-braced arch. This arch has a main span 550 feet long, supporting at each end a trussed span of 115 feet. The form of the main arch is as shown in Fig. 1. Each truss has a batter of 1 horizontal to 10 vertical, with a width between the axes of the upper chord of 30 feet; this makes the axes of the rib 34 feet apart at the crown and 56 feet 7.75 inches at skewback centres. The axis of the rib at the centre is 113.9 feet above the skewback line as measured in the plane of the truss.

Influence on Weight of Truss.—The investigation of the influence of the position of the crown hinge on the weight of the structure, conducted by Mr. Beltaire, was carried out by computing the maximum, minimum and reversed stresses for each member graphically and then computing the required section areas. The area for dead load was found separately from that for live load and to the latter was added 80% of the reserved stress.

In computing the weight of members, the theoretic weight was used, i.e., the weight as computed from the formula

$$W = 3.4 A l$$

in which W = weight of member; A = area of section in square inches; l = length of member in feet and 3.4 = weight of steel bar one foot long and one square inch in cross-section. This ignores all latticing and details at joints and hence it is but a very close approximation; experience shows that this theoretic weight is slightly less than the actual weight, the ratio of actual to theoretic weight averaging about 1.25.

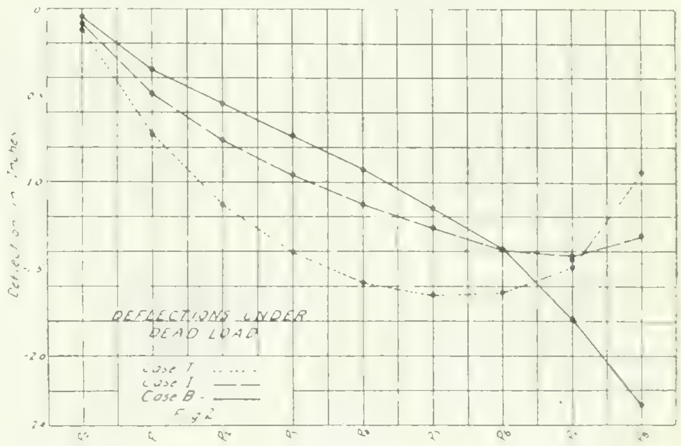


Fig. 2.

The weight of the structure in Case B was found to be 3132.96 kips, of which 12.9% was for the weight of upper chord members, 43.4% for lower chord members, 20.1% for the diagonals, and 23.6% for verticals. The weight in Case I was 2857.616 kips, as follows: Upper chord members, 13.2%; lower chord members, 36.9%; diagonals, 24.8%, and verticals, 25.1%. The weight in Case T was 2762.588 kips, as follows: Upper chord members, 19.1%; lower chord members, 32.8%; diagonals, 23.3%, and verticals, 24.8%. The weight in Case T was 88.17% of that of Case B and Case I 91.21% of that of Case B.

Conclusions.—From the above it is seen that Case T is the most economical design where a three-hinged arch is to be erected, it requiring 11.83 per cent. less material than Case B and 3.4 per cent. less than Case I. In a structure of the magnitude of the arch used for the computations, the economical advantage would amount to

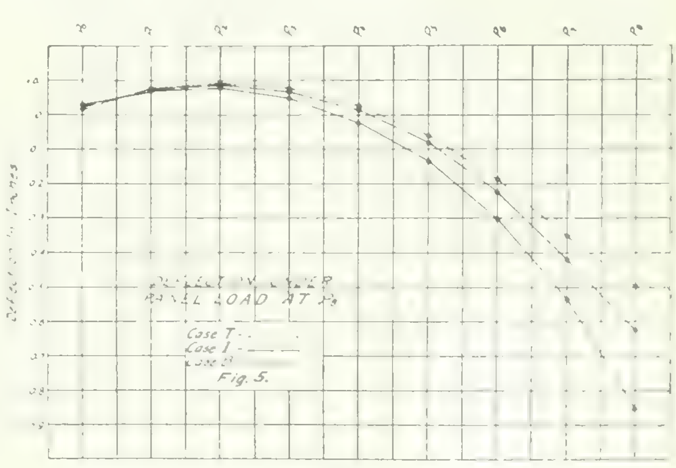


Fig. 3.

about $11,000, or $1,000 for each gain in per cent. The great gain made by Case T was caused by a clause in the specifications in regard to reversal of stress; in this case there was no reversal of stress in the upper chord members, while in Case B every member was reversed; the

same thing was true for the diagonals and verticals with the possible exception of one or two members in each set. Therefore, if the design were made under a smaller factor than 80 per cent., Case T would not be as large.

In view of the above, the writers claim it is only fair to state that where three-hinged spandrel arches are to be designed, Case T will be the cheapest and most advantageous.

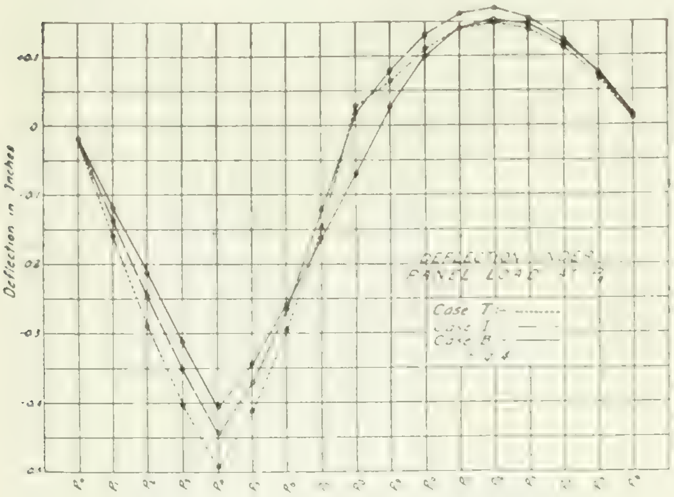


Fig. 4.

Influence of Deflections.—The stresses, sections, etc., which were found in the first study for a comparison of weights were used by R. W. Parkhurst to find deflections. Four cases were considered, those under dead load, full live load, and concentrated panel loads at the quarter points and middle of the span respectively. The stresses due to the load P_4 were computed directly by the analytic method and those for the loads P_8 and P_{12} were found by the graphic method. From the stresses and given sections, the elongations were computed and deflection diagrams drawn. The results are given in the form of curves in Figs. 2, 3, 4 and 5.

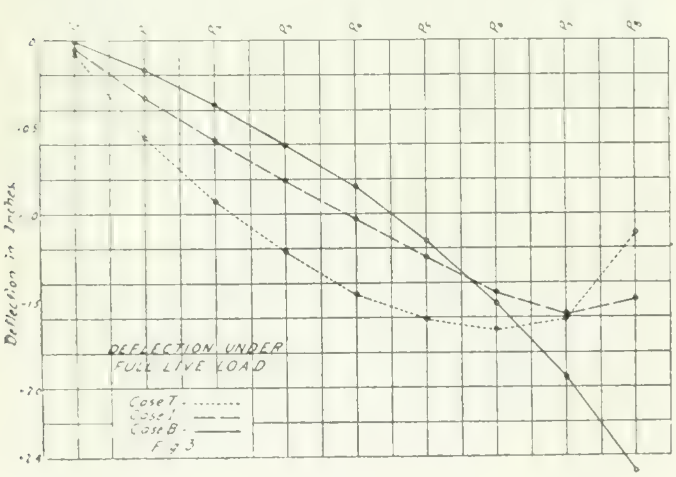


Fig. 5.

Conclusions.—Examination of the curves indicate that under dead load and full live load, Case B possesses greater stiffness at the quarter point than the other types, but deflects considerably at the centre. Case I shows good average values of deflection, while Case T shows great deflection at the quarter point, but comparatively little at the centre.

For the load at the quarter point, Case B shows greater stiffness throughout, while Case T allows considerable deflection under the load, but about the same amount of upward deflection for the unloaded half of the span, as Case B. Case I indicates average deflection under the load, but greater upward deflection. Both Cases I and T remain about stationary at the centre.

Under the load P_8, Case B shows greater deflection than the other types, Case I again ranking as intermediate.

From the preceding results, Case T shows considerable deflection in all cases except under the load P_8, while Case I seems to give the best average throughout. Case B is not considered on account of its comparatively great weight as shown above. For extremely light loads, Case T might be employed on account of cheapness of material, but since Case I is but 3.4 per cent. heavier, the extra cost should not be great, and where the loads are larger, and where additional stiffness is required, the latter arrangement might well be employed to advantage.

ELECTRICITY IN INCINERATOR OPERATION.

THE municipal incinerator just accepted by the city of Pasadena, Cal., has at least one electrical feature that is unique, a system of four elevators which receive the loads from the dump wagons at the ground level. These cars are of iron and each has a capacity of about two tons. The dump wagons shoot their loads directly into the elevator car, which is set with its upper edge flush with the floor, as shown in Fig. 1. The car is then hoisted by electrical power to the top story of the building, running between upright tracks. At the top these tracks are curved in such a way as to turn the car almost upside down, leaving it at an angle

Electric Elevator for Receiving Garbage.

of 45° with its mouth below the base and flat against the furnace door. The door is then hoisted, also by electrical power and the contents of the elevator are shot into the furnace. Besides this automatic dumping device, the fan which adds to the draft of the 152-foot smokestack is electrically operated, while, of course, the lighting is electrical. Current is obtained from the municipal lighting plant, which is only 500 feet distant. It is charged against the incinerator account, and costs about 25 cents a day for operating the hoist and about $1.50 a day for operating the blower. In constructing the incinerator, it was planned to install a large boiler on the top floor to take advantage of the resulting heat from the furnaces and generate steam power to be delivered to the city lighting plant, but this plan has not been carried out as yet. The incinerator is a reinforced concrete structure,

costing $46,000 and has a capacity of 30 tons of garbage a day. It is of the Fredsmith type, and depends largely upon the dry rubbish delivered as a fuel to destroy the wet refuse.

GARBAGE DISPOSAL COSTS.

THE question of garbage disposal has reached an acute stage in Chicago, the dispute between the city and the former contractor for disposal and the inability of the city authorities to decide upon new methods of disposal have continued until the old contract expired and have resulted in a refusal of the contractor to continue pending settlement of the question, so that now the property owners are begged to dispose of the garbage as nearly as possible upon their own premises, and the city is treating with chemicals what it must collect before dumping it in abandoned clay holes.

The discussion has resulted in the presentation of much information of greater or less value upon the comparative values and costs of various methods of disposal. The following information, from "Municipal Engineering," is derived from comparative estimates made by M. de Ronore, of Paris, France:—

An assumption of 1,000 tons of material for disposal per day is made, of which, according to the Parisian average, 40 per cent. will be garbage and street sweepings and 60 per cent. dry, combustible rubbish. The average cost for incineration of wet garbage is said to be $2 a ton and that of incinerating a mixture of equal parts of dry waste and wet garbage over 50 cents a ton. The dry, combustible rubbish has a calorific value one-fifth that of good coal, while the mixture with garbage has no calorific value.

The mixed method of garbage disposal produces a fertilizer weighing about 20 per cent. of the garbage treated, this weight being about one-half that of the portion of the garbage reducible to fertilizer. The remaining three-fifths of the mixture is burned and produces electrical energy. The cost of a plant of twelve groups, each group with a capacity for 10 tons per hour, is estimated as follows:—

Land, 4.5 acres to be furnished by city, is not included:—

Buldings for the plant	$ 300,000
Offices and lodgings	60,000
The Mechanical Installations—	
Wagon-loading apparatus	$ 60,000
Sorting, crushing, etc., machinery	80,000
Producer system incinerators	220,000
Boilers	120,000
Electrical machinery	180,000
Expenses, loading, freight, etc., on construction materials and machinery	30,000
Paving about plant	50,000
Conduits and pipes for water and electricity	80,000
Side track	40,000
Miscellaneous	40,000
Contingencies	80,000
Total estimated cost of plant	$1,340,000

The cost of operation of this plant is not stated, but the amount of labor required is estimated at somewhat less than twice that required in an incinerator plant and about one-fifth that required for a reduction plant of about the same capacity.

The income from the plant using the mixed method is estimated as follows:—

The 400 tons of organic matter per day will produce 200 tons of fertilizer, or 73,000 tons per year. This is valued at $5 a ton, or $365,000 a year. The combustible waste is estimated to produce 50 k.w.-hr. of electricity per ton, and the 600 tons per day (219,000 tons per year) would produce 10,950,000 k.w.-hr. per year. Deducting 2,190,000 k.w.-hr. required about the plant leaves 8,760,000 k.w.-hr. for sale, which, at 2 cents, would produce $175,200. The total gross income from the plant for year would, therefore, be $530,200. In addition, there would be income from sale of rags, metals, etc., recovered.

These estimates may not fit American conditions exactly, but can be modified to fit them, and are certainly interesting. Even after deducting an expense of operation equal to that of running an incinerator plant with the addition of the greater labor cost in the mixed method plant at, say, $1 a ton incinerated, a handsome profit remains for the mixed method.

THE STRENGTH OF WIRE ROPES.

IT is frequently assumed that the stress causes in wires by bending them over pulleys is considerably lower when the wires are twisted in one or several strands than when single wires are tested. According to Bach, the former stress would be only three-eighths of the latter, and some authorities have based their regulations as to the strength of lift-ropes on the assumption of this coefficient. Bach was attacked in 1907 by Isaach-Sen, and the latter was supported by Bock, and last year by Wehage, who directed attention to the strains left in the ropes by the stranding. "Glück Auf," in a recent number, furnishes an interesting contribution to this question, though it is only based on preliminary experiments. Professor G. Benoit and Mr. Woernle are engaged on an investigation of the strength and durability of wire ropes, which they are conducting in the laboratory for hoisting-machinery of the Technical High School at Karlsruhe. This research will occupy them for some time to come; but as their experiments are pretty conclusive about the deleterious influences of twisting, they have published their preliminary results, which were reviewed lately in "Engineering," London.

The experiments in question were made with a patent cast-steel wire, 1 mm. in diameter, which they found had a strength of from 174 kg. to 180 kg. per sq. mm. (110 to 114 tons per sq. in.), the guaranteed strength being 160 kg. per sq. mm. The wire was tested as it was, and also twisted to a strand of seven wires, 3.1 mm. in diameter, there being six steel wires and a core of softer wire of a trength of about 86 kg. per sq. mm. This rope gave a strength of 805 kg.; the soft core was generally not broken in the test, because it stretched considerably. Three of these strands were then combined to a rope of 6.8 mm. in diameter, and five to a rope of 8.5 mm. in diameter; the latter cable was provided with a hemp core, the former not. The wires and ropes were applied to a pulley which was turned to and fro through an angle of about 90 deg. at the rate of 1,000 turns per hour; the bending and unbending of the wires thus took place always in the same direction; further experiments with alternating bending to different radii, etc., are now being made. A turn is understood to signify bending of the wire from the straight and back to the straight.

The size of wire under test was generally such that the stress amounted to 8 kg. per sq. mm. (5 tons per sq. in.). The pulleys were made of cast iron or zinc, and were used either in rough condition or filed or properly

turned true. Though sufficient oil was always supplied, and there seemed to be no damage directly due to friction, the good finish of the pulleys had a very marked beneficial influence on the life of the ropes. The single wires stood 198,710 bends; the twisted strand had one or two wires broken after 44,800 and 47,190 bends. The pulley diameter was 175.4 mm.

A slightly larger pulley, 180.4 mm. in diameter, was then taken. On this single wires stood from 122,000 to 200,000 bends; the twisted strand became injured in three wires after 40,860 bends; the cable of three ropes had one wire broken after 22,860 bends, and was practically done for after 36,440 bends; the five-rope wire began to fail after 35,000 bends, and was given up after 40,000 bends.

The twisted ropes thus proved to be much less safe than the untwisted wires, and it occurred to the investigators that the twisting might in itself be responsible for the loss of strength. The wires, ropes, and cables (except the cable with a hemp core) were therefore annealed. In the case of the wires and wire bundles the annealing was fully carried through; the strength of the wire was thereby reduced to 93 kg. per sq. mm. In the case of the twisted ropes the heating was only carried so far, that the cut rope did not show any tendency to uncoil. The wires stood 47,700 bends, the twisted wires 37,000 and 42,000 bends, when the rope was destroyed; the cable of three ropes failed after 15,400 bends, and was quite destroyed by 21,850 bends. In other tests the untwisted wires stood from 47,700 to 70,900 bends; in the simple rope wires began to break after 50,850 bends, and the experiments had to be abandoned after 70,020 bends. That the cable of three ropes proved weakest may be due to special accidental features as to the relative dimensions of the parts. But the experiments thus demonstrate that the twisting leaves considerable strains in wire ropes, and especially on those made of high-class steels, which are chiefly used in mine haulage and winding.

LAYING SIDEWALKS IN WASHINGTON.

One-half of the cost of laying sidewalks in Washington, D.C., is assessed against the abutting property, and ordinarily the commissioners do not order sidewalk construction until they have received a petition from the owners of more than one-half of the frontage along a block. An exception is made, however, where a walk becomes dangerous, the commissioners order the work done in such cases without waiting for a petition. The law requires them to advertise for two weeks their intention to lay sidewalks and curbs, and, after a hearing, to order the work done when, in their opinion, it is necessary for the public safety, health, comfort and convenience.

During the last fiscal year, $225,000, according to The Municipal Journal, was expended in paving sidewalks abutting private property, and $7,000 in placing sidewalks and curbs around government reservations. The sidewalks were constructed of cement by contract. The alleys were paved with asphalt block or vitrified block by day labor, 23,422 square yards of vitrified block and 18,214 square yards of asphalt block, both on a gravel base, having been laid last year. Cement sidewalks were laid by contract for the following prices: Large jobs adjoining paved streets, 90 cents per square yard; large jobs adjoining unpaved streets and all small jobs, $1.20 a square yard. Contracts have been let for next year's sidewalk work at 92¾ cents and $1.16¾, respectively.

PRODUCER GAS FROM WOOD.

Producer gas from wood was dealt with in a lecture recently delivered by G. E. Lygo before the Junior Institution of Engineers. It was only recently, he said, that gas plant makers had given serious attention to the subject of utilizing wood for use in gas producers. This was no doubt due to the higher price of a wood waste plant as compared with an anthracite plant and the low price of anthracite, but with the increased cost of coal, manufacturers having combustible waste materials of little value and difficult to dispose of were looking out for means of utilizing them, and the advent of reliable wood waste suction plants had given them an opportunity of effecting considerable economy. In these plants all kinds of wood, from sawdust to pieces 6 inches in diameter, cotton seeds, cocoanut shells, fiber, and dust, sugarcane, coffee husks, rice husks, spent tanning bark, rubber leaf waste, surface peat, etc., could be used.

Referring to the design of the plant, many points had to be taken into consideration which were not needed with an anthracite plant. The area of the generator was governed by the nature and size of the fuel, but, roughly speaking, it was 2½ times that required for coal fuel. The depth of the fuel depended upon its size and density. A deep fuel bed was necessary for large pieces of wood, else air passed through and ignited the gas in the top of the generator.

Small, dense fuel, such as sawdust and coffee husks, required a comparatively shallow bed, or its resistance would interfere with the working of the engine. The internal hopper must be designed to suit the fuel, some fuels falling evenly in the generator, while others formed a cone in the centre. The external hopper was of large capacity. A vaporizer was not required, as there was no necessity to keep down the temperature in the combustion zone, and the loss of hydrogen was more than made up by the volatile gases in the fuel.

The gas must be cooled and washed immediately it left the generator, else the heavy tar and dust in suspension would be deposited and choke the connecting piping. In Whitfield plants an anti-fluctuator was provided, which insured a steady flow of gas from the generator. The variation of pressure on the suction stroke rarely exceeded 1 inch of water, whereas 6 inches was not uncommon in plants without the anti-fluctuator.

The calorific value of wood when air-dried was approximately 6,000 B.t.u. per pound. The amount consumed per brake horse-power depended upon the moisture, which amounted to 10 to 20 per cent. in air-dried wood and 30 to 50 per cent. in fresh timber. Fuel which contained excess of moisture had to be dried until it did not exceed 60 per cent., otherwise it was difficult to make the generator fire burn evenly. The gas produced was of higher value than that from anthracite, namely, about 150 B.t.u. to 170 B.t.u. per cubic foot, as against 120 B.t.u. to 140 B.t.u. from the latter.

As regards cost of working, a test made with a Whitfield producer supplying an 84 brake-horse-power engine coupled to a 105 volts dynamo gave 540 B.t.u. for 2,072 pounds of fuel consumed, or 3.83 pounds of fuel per kilowatt. The test extended over 10 hours, and the fuel consisting of oak and elm sawdust and chips from working machinery, had no value for other purposes.

In one factory, before the installation of the producer, the same work had been done by a steam plant, when, in addition to the same amount of wood waste, upward of 500 tons of coal per annum were consumed.

The Canadian Engineer

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CONTENTS OF THIS ISSUE.

ADOPTION OF LIQUID FUEL FOR MARINE WORK IN BRITISH COLUMBIA.

That oil for fuel is speedily replacing coal on British Columbia harbor craft is a fact that is daily becoming more noticeable. Practically all the Government vessels plying in and out of Canadian ports on the Pacific Coast are using oil burners, or will be using them in another six months. The Marine Department was the first to make the change, while now the tug boats, dredges, snag-scows, tenders, etc., operated by the Department of Public Works in Vancouver and Victoria harbors, and on the Fraser River, are experiencing a similar conversion.

It has been found that this is a change for greater efficiency, and particularly so in the operation of dredging machinery. A reduced pay roll is noticeable in the stoke-hold of the vessels that have adopted the new system, about half the number of firemen being required as when coal was the steam producer.

Of course, the adoption of oil has advanced its price. At the present time, merchants are maintaining but a slight difference in the matter of cost between oil and coal. Nevertheless, the marine yards at Esquimalt are doing a rushing business in the conversion into oil burners of a veritable fleet of dredges, tugs, and the like.

Among those vessels upon which the oil system has been found to give excellent service are the Mastodon, operating around Vancouver; The Fruhling, keeping down the sand banks on the Fraser, and the Lobnitz, engaged in rock excavating in Vancouver harbor. The New Westminster stern-wheel suction dredge, King Edward, and the dipper dredge, Ajax, of Victoria, are among the craft at present at Esquimalt undergoing the installation of the oil system of steam generation.

FEDERAL CITY PLANNING COMMISSION.

Ottawa, like Washington, seems destined to become a purely parliamentary centre. The House and the Senate have never been enthusiastic about making the city a great manufacturing or industrial point. Early this month the Ottawa citizens voted by a decisive majority against the continuance of the publicity bureau that had been organized to attract industries. The civic body seems to be in sympathy with the desire of Parliament to make Ottawa a real Capital—a Federal City—a place of dignity, impressiveness and majesty.

In this work the chief factor will be the Federal City Planning Commission, recently appointed and as yet without permanent staff. This Commission is said to be contemplating improvements for Ottawa and surrounding district that will likely total fifty million dollars. The work will be spread over a period of twenty or twenty-five years, in all probability. Federal buildings, parks, railroads, streets, boulevards and the general view from Capital Hill will be within the scope of the Commission's activities. A Capital of a half million population will be planned for—the Commission will not be near-sighted.

The work includes Hull as well as Ottawa—on account of the importance of Hull as the background for the Capital. The Rideau Canal and the Ottawa, Rideau and Gatineau Rivers are also included—with the possibility of the Rideau River being diverted—and of a huge joint power scheme being developed. Great changes will gradually be wrought in a territory about sixteen miles square.

And may we add the hope that when in 1934 the visitor to Ottawa has been duly impressed with the dignity and importance of Canada's Capital, that he will be able to obtain a drink of pure water—whether from the Gatineau Lakes or from a mechanical filtration plant.

FACTORY CONSTRUCTION IN REINFORCED CONCRETE.

There are two types of reinforced concrete factory construction—the one with outside bearing walls of concrete and few openings, the other, the skeleton type of construction, the walls being simply filling-in panels, built afterwards. It has been pointed out that the latter is the easier to build and the more economical, but that it calls for a consideration of the following points: The column and pilaster footings only need go down to a solid bearing, unless an excavated basement is required. Where there is a basement light walls reinforced horizontally from column to column, or vertically from the basement floor to the first floor, will retain the earth, the reactions being taken by the columns or by the basement and the first floor, while the walls may be reinforced to carry themselves from footing to footing, requiring no foundations of their own.

Where there is no basement the outside walls need only go far enough down to prevent frost working in under them, with possibly a shallow trench filled with cinders or gravel underneath. They can be reinforced to carry themselves from pier to pier and to support the walls above. By building the footings first, and carefully filling, settling, and levelling the earth and laying the floor on the ground, the shores to support the false work can be cut of even lengths, and there will be a good level surface to shore from. Columns and floors are built first, as in skeleton steel construction, and the outside panel walls are self-supporting, but not weight-bearing. They are built in between the pilasters entirely independently of the floors. They may be built at a later time, furnishing a convenient method of keeping the concrete gang busy while the concrete floors are setting or the wood forms are being shifted from floor to floor, or when the weather is too wet or too cold to permit of the laying of the more-important work of floor construction.

CANADIAN RAILWAY CONSTRUCTION IN 1913.

During the past year Canada's railway lines were extended by a total of over 3,000 miles of single track, not including some 450 miles of second tracking. Comparing this with 2,230 miles in 1912, 1,898 miles in 1911, 1,844 miles in 1910, 1,488 miles in 1909, and 1,250 miles in 1908, the mileage returns exhibit a rapid increase.

As will be noted by the table of statistics given on another page of this issue, the volume of construction work that has developed during the year greatly exceeds the figures of any previous year. There are over 3,000 miles in various stages of actual construction at the present time.

The Canadian Northern added over 1,275 miles to its trackage; 206 miles in British Columbia, 500 miles in Alberta, Saskatchewan and Manitoba, and about 580 miles in Quebec and Ontario. The Canadian Pacific laid nearly 600 miles and 200 miles on its Western and Eastern lines respectively. The Grand Trunk Pacific laid 480 miles in the West. The Transcontinental added 90 miles.

In addition to the above figures the Canadian Pacific built over 450 miles of second track, approximately two-thirds of which belongs to the main line west of Winnipeg.

Comparing Canada's 1913 railway building with other American countries, it is noticeable that the total single track construction of United States' railways during the same period of time is approximately equal to Canadian development, the difference being remarkably small. In 1912, the difference was approximately 750 miles. During both years, however, the United States railways have exceeded Canada's second track additions by about 900 miles.

The tempestuous conditions that have obtained in Mexico during the past year have made an enormous difference in the returns for construction activities in that country. During last year only 38 miles of line were completed as against 210 miles in 1912, and 350 miles in 1911.

LETTERS TO THE EDITOR.

Re the Proposed New Water Supply for Ottawa.

Sir,—It is a most extraordinary thing to find to-day in this country a plan to go to distant lakes at an expenditure of about $8,000,000 for the water supply of a city of the size and location of Ottawa, seriously recommended. Still more extraordinary is it to find it seriously considered.

There are to-day dozens of purification plants in this country and over the border in successful operation which, with some slight modifications to meet conditions of the Ottawa River water, would satisfactorily purify and render colorless the present Ottawa supply.

From the writer's experience with a 25,000,000-gallon filter plant, handling during part of each year the same water as obtains at Ottawa in the Ottawa River, he can say that $550,000 would erect and completely equip a 25,000,000-gallon filter plant of the highest efficiency at Ottawa which would give an absolutely satisfactory result using the Ottawa River water.

The above figure does not include the necessary connections with the city's present pumping plant as the cost of this would depend upon the relative location of the two plants.

But, as to the feasibility and absolute fitness of a modern so-called mechanical gravity filtration plant for the Ottawa water supply, there is not the least doubt.

Why throw away about $7,450,000 on the undertaking and then perhaps leave doubt as to the absolute safety of the supply?

F. H. PITCHER,
General Manager and Chief Engineer,
Montreal Water and Power Company.

Montreal, Jan. 6th, 1914.

* * * *

On Expert Opinions of the Fixed Carbon Test.

Sir,—The writer has followed with considerable interest the series of articles appearing in your publication on the fixed carbon question and, with your permission, will supplement his original contribution with the following remarks:—

Three of your contributors advocate a fixed carbon requirement in some form or other; yet their different

views as to its application add more to the uncertainty of the subject than they accomplish as arguments for such a requirement.

Let us assume for the present that the test itself is a scientific determination which gives consistent results in the hands of skilled operators and that engineers are not interested in requirements which favor or discriminate against any special product or class of bituminous materials. With this hypothesis, let us review the statements of your fixed carbon advocates.

In your issue of November 13th, Mr. Pullar recommends that different fixed carbon limits be set for the various classes of asphalts in competition. This would, of course, be fair to all materials provided, of course, the engineer did not neglect any of the "classes" in his specification, but would it not be a step in a dangerous direction? Would not a manufacturer be justified in asking that different limits be set for other requirements such as ductility, susceptibility, etc., in order to suit the characteristics of his special product? At best this would involve complicated specifications likely to revert us to the practice of purchasing by "brand," the elimination of which is the very fundamental principle of the open scientific specification.

Furthermore, how would the method take care of mixtures of asphalts often used with much success, also fluxed materials. I have in mind the practice of some cities which base their requirements not on a crude or refined material but draw the specification for the finished asphalt cement ready for the paving mixture.

In Mr. Kirschbraun's discussion of December 4th, it is recommended that fixed carbon be limited by a purely arbitrary formula of which two essential factors are the fixed carbon and asphalt yield of the crude. As there is considerable variation in refining practice, how will the testing laboratory arrive at the yield of asphalt? Will they determine this by some laboratory test which may or may not represent manufacturing figures or will they look to the producer for this data? Without means of verification in either case, the inspecting chemist will be safer in basing judgment on the finished product alone.

Mr. Richardson, in the issue of December 18th, voices our indebtedness to Messrs. Pullar and Kirschbraun for their efforts in showing the direction of importance and interpretation of the fixed carbon requirement. How do these directions coincide with his recommendations as a result of so many years of experience? Both commentaries oppose any definite maximum limit but, to use his words "if the highest grade of material is desired to the exclusion of the cheaper residual pitches made from oils . . . . ," let us see what protection the city will secure by adopting Mr. Richardson's maximum limit of 15%.

In the sixth paragraph of Mr. Pullar's argument he mentions an asphalt showing 12.32 per cent. of fixed carbon which "was very poor and not suitable for bituminous work." Later on, in the twelfth paragraph we have, in striking contrast, the statement that "owing to peculiar characteristics of oils obtained from Mexico . . . a much higher fixed carbon is obtained . . . averaging between 14% and 18% for the well-known brands," and still further on we read that "Mexican oils will give satisfactory results despite comparatively high fixed carbon." I quite agree that the two gentlemen have done much to clear up the fixed carbon subject certainly in so far as a definite maximum limit is concerned.

The writer has not approached this subject in a commercial manner with the object of exploiting or condemning a brand or class of material, neither is he adverse to tests which show up inferiority but he has, independent of this discussion, found "fixed carbon" too empirical to be of any use as a refinery or inspecting test.

We may theorize as to "cracking," "over-heating" or other evidences of "improper refining," but if the test by which these defects are to be determined is a variable quantity then our structures of theory and argument become mere creations of sophistry. Take the fixed carbon reports of my sample No. 215, published in your issue of November 27th, 1913. From the variety of results submitted this sample could fall within several of Mr. Pullar's "classes"; would meet a like judgment by Mr. Kirschbraun's formula even knowing the fixed carbon and asphalt yield of the crude; also from the report of laboratory "B" it is within Mr. Richardson's flat limit of 15% though made from Mexican oil. Which of the six reports will one select?

To the writer it would seem that such chemical problems, which are at best uncertain, would be avoided by engineers until settled by the profession to which they more appropriately belong. If, however, the engineers wish a harmless excursion into the less familiar field, let them call for fixed carbon reports from several chemists on the same sample when, I feel sure, the absurdity of the situation will be realized.

LEROY M. LAW.

Baltimore, Md., Jan. 6, 1914.

* * * *

A Reply to Prof. Richardson re "Fixed Carbon."

Sir,—I notice in your issue of December 18th an article by Mr. Clifford Richardson—who, as he states, has had many years' experience in the determination of the fixed carbon test and other characteristics of native bitumen for the Barber Asphalt Paving Company—as to the desirability of maintaining said fixed carbon determination in specifications drawn for the purchase of asphalt.

Mr. Richardson argues:—

"If an engineer, in the light of service tests, prefers material which has been well proved to be satisfactory, rather than residual pitch which has been a failure or is of an experimental nature, he will properly introduce into his specifications a provision that no bitumen would be acceptable under them which contains more than 15% of fixed carbon."

I am surprised that Mr. Richardson should at last acknowledge the real purpose of the fixed carbon test, and advise that an engineer should introduce that test in his specifications, in order that only the expensive natural asphalts—Trinidad and Bermudez—shall be used, when a franker method would be to specify these materials by name.

The fixed carbon test, except for the purpose of making a market for the so-called "natural asphalts" above stated, is now abandoned, and all up-to-date municipalities by abandoning the same are obtaining the advantage of competition, and are securing asphalt that has been proven better and cheaper than the impure natural asphalts, which were used in the early days of the paving industry, simply because there were no others. Much impartial expert testimony has proven that the fixed carbon test has no value in determining the quality of asphalt or its fitness for paving material.

EDWARD SLADE.

Montreal, January 5th, 1914.

RAILWAY TUNNELLING.

By **Leonard Goodday, C.E., M.E.,**
Late of the British Admiralty.

The following is not presented as being new to engineers, nor to contain formulæ or positive rules for constructing such works, as none can be laid down; no two tunnels ever being exactly alike in conditions affecting their construction. However, it is hoped that assistants to engineers and contractors will find the information of material practical value.

Tunnels should be sparingly used. They require great care and honest workmanship in construction, repairs being generally accompanied by great expense and delay to important traffic.

Light and Heavy Ground.—When a cutting attains 70 feet in depth it is generally advisable to tunnel. A cutting of this depth, for a double line of rails, with 27 feet width at formation, and 1½ to 1 slopes, contains about 1,027 cu. yd. of excavation per yard run. A tunnel in sound rock requiring no lining is a comparatively simple piece of work, but those in unsound ground, requiring a lining, are sometimes very difficult and troublesome, especially where the height to the surface of ground over the tunnel is small.

As a fact, the greater the distance between the surface and the top of the tunnel, the lighter will be the ground generally, and therefore the greater the ease of construction. The reason is that when near the surface, mining operations cause the whole of the intervening ground to be disturbed. Cracks appear on the surface, and the whole weight of the earth has to be borne on the timber and lining. This condition of things is called "heavy ground." When the tunnelling is at a considerable depth, the disturbance caused by mining is arrested before it comes to the surface, and the weight is borne in the ground itself, i.e., "keyed in," while the ground is then called "light." Ground of 50 feet or less is likely to be heavy unless the geological formation is a strong one. When operations are commenced the strata and direction of "dip" should be studied so that the probable pressure may be ascertained. Sinking shafts and driving headings will assist in this work.

"Clay backs" often exist between the faults in rock, the stone having been upheaved and broken in enormous wedges, the sides forming a zigzag line vertical to the line of the tunnel. Water, having run between the sides of these wedges, has deposited clay which readily becomes slippery. The first length may be driven through one of these wedges, with its apex downwards. Two, perhaps three, lengths may be got in, and no great weight encountered, where the wedge is pointing downwards. If the wedge points upwards a great weight is suddenly brought upon the timber, because the rock, having its base cut away, slides down between its clay sides, and an increased thickness of lining will be necessary.

Clay is not a desirable substance to tunnel through, however sound it may appear. Water and air have a great effect upon it. The former renders it unstable and dislodges it from behind the timber, causing the latter to give, while the air makes it swell, crushing and breaking the timber.

In heavy tunnelling a thick lining is required, which cannot be determined upon until the work has been partially opened out. In light tunnelling the same process must also be gone through, but in a modified form.

Sinking Working Shafts.—The line once determined, it does not follow that shafts should be permanent, but one may well be so if the tunnel is over 700 yards long and if there will be much traffic. This shaft will be useful for steam clearance and ventilation purposes. If an engine passing through leaves the tunnel full of steam, the engine driver of the next entering train is unable to see his signals. The number of shafts to be sunk is regulated by length of tunnel and time allowed for its completion. Two faces should be worked from each shaft, and a length for each mined and lined complete for, say, five yards in every 20 shifts or 10 working days and nights. One shift would work from each shaft and one work to the shaft from a "break-up." Allowing 600 working shifts per year and a full gang for every two faces, 30 lengths would be mined and lined per annum in each direction, 15 being worked from "break-up" faces.

Suppose a tunnel of one mile length has to be completed in one year, how many shafts should be sunk?

One should be sunk at each end of the tunnel, and mining carried on from it in one direction only. In the other direction a heading may be driven, for expediting the excavation of the cuttings leading up to the tunnel, if heavy. The possible work to be done in both directions is 300 yards per annum, and in 1½ years 450 yards, leaving 1,310 yards to be worked from, say, 3 intermediate shafts. With this number it may be completed in the specified time. Sinking these 5 shafts and driving the headings will take at least 6 months. A "break-up" should not be commenced in a heading until the headings are all through, and centre line accurately fixed. It will be seen from this that for a tunnel 1 mile in length with 5 shafts 2 years is not too long. Shafts should be nearly equidistant from each other and the lowest points should not always be chosen for a site; for, though of less depth to sink, surface water and pumpage will naturally drain into it. Water is one of the greatest obstacles encountered in tunnel works. Also, the "bank" or top of shafts require raising above the surface, to get tipping room for the excavated material. Temporary shafts should be at least 9 ft. square and of timber, and sunk vertically. The settings of timber should be sound, 10 by 10-in., halved into one another at the angles, and plugged through the halving. They should be 4 ft. apart, centre to centre, the first one placed about surface level. Poling boards 1½ or 2 in. thick will not be too strong for lining, and if thicker ones are necessary short ends of planks will serve efficiently. The first setting having been let in sufficiently to keep steady, the poling boards are set up around the outside and excavation carried out inside and from under the "setting," the boards being hammered down and following the excavation. Temporary props are kept under the angles to prevent settling. When 4 ft. has been excavated another setting can be placed vertically under the first, taking care that the lower ends of the first set of poling boards are behind the second setting, and so on. If the ground around and close to shaft is level, the pit mouth should be built up a few feet, this giving height for a tip for excavation. A "jack roll" may now be set up over this shaft with 2 small skips attached on opposite sides of the winding barrel, so that as one is ascending the empty one is descending. For raising the excavation and water this will serve very well for depth of, say, 40 ft., but a winding engine or horse gin will eventually be required for handling the material.

While the above is going on, arrangements must be made for erecting a "poppet head" over the pit's mouth,

and forming a gin ring with excavation already coming up. When a pit is over 25 yds. deep, a horse gin is too slow, and a winding engine is required. It should not be less than 14 h.p., and should be of the ordinary portable type—with its wheels removed and the engine resting on a solid bed. It should operate by belt, a friction winding gear, allowing continuous operation of the engine, and doing away with dangerous stopping and reversing. The skip descends by gravity and is regulated by a powerful foot-brake. A distinctive mark is often fastened to the steel wire rope to indicate, in passing over the pulley of the head gear, that the skip is at a certain distance from the bottom of the shaft; another mark near the other end of the rope indicating the skip's position when near the top. A bell should also be connected with top and bottom of shaft, and arranged to automatically ring when the skip is nearing top or bottom. When a skip is descending, the engine, although doing no work, should be kept running, and when a full skip is attached, and ready for lifting, the hanger-on at the bottom rings the bell, whereupon the brakesman simply throws the drum into gear with the engine. This does away with all jerking.

Suppose a lining is fixed at 2¼ ft. or 6 half brick courses, that the lengths proposed shall be 5 yards each, and that the bars necessary for supporting the ground while it is being mined and lined shall be 1½ ft. in diameter at the butt end. Suppose also that the weight upon the bars will cause them to sag or settle down 12 in. in depth before the arch is keyed (which is called the "drop"—the bar must be kept up to that extent to allow for such sagging) that the brickwork may be put in of full thickness under the sagged bar. It follows that the top side or "back" of bar must be 2½ ft. higher than the extrados, and that the under side or belly of the headtree of the top heading must be kept higher up and above this to allow for the bar being placed under it. Drive the top heading, and on arriving at the two open ends of the tunnel, the passage through it will be found at a higher level than the formation of cutting, and a consequent lift of some 15 feet for all material passing in or out of the tunnel. Next decide upon the position of the "break-up" between the shafts. A "break-up" is formed by opening out and lining a length midway between two shafts, after the heading is driven between them. This creates at once

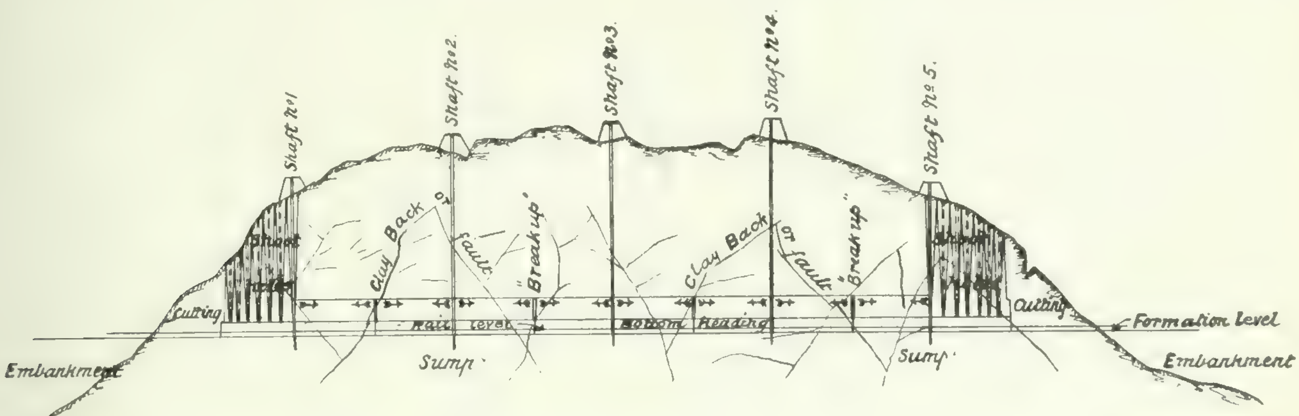

Fig. 1.—Longitudinal Section of a One-mile Tunnel.

Over the pit-mouth a bogie, or rolly, on 4 iron wheels about 12 or 15 in. in diameter and of a gauge equal to the full width of the shaft, should run on light rails laid back into a sort of dock sufficiently far to allow the rolly to be pushed back clear of the pit mouth. On the rolly are laid light rails at 2-ft. or 2-ft. 6-in. gauge on which are run small trollies. The full skip ascends clear of the mouth, the rolly with the trolly on it is pushed over the mouth and the skip then lowered upon the trolly. It is then disconnected from the winding rope and an empty skip attached. The rolly is then pushed back into the dock while the trolly and skip are run to the tip head.

At the bottom of the shaft a sump about 3 yds. deep is formed in the same way as the shaft, to collect water. A frame is built over it to form a cover to withstand stones, etc., which may fall down the shaft.

Headings.—A heading must be driven as a communication all through and between the working faces, and for accurately setting out a centre line below ground. Either a bottom heading at formation, or a top heading with its top a little higher than the extrados of the arch. A top heading must be made for each length, being necessary for lining in. It is necessary, also, for getting the "crownbar" into position. It is argued that, as the driving of this heading is most expensive in mining for the bars, why not drive right through at the outset. This is the only good argument in its favor as against a "bottom heading."

two new working faces, and facilitates the progress of mining and lining. It also permits more hands being employed, and the progress is thereby expedited. Each face is worked by a gang from each shaft. As the "break-up" is formed from a top heading whose bottom is about 15 feet above formation level all excavation below the bottom has to be raised into the heading and to the face working from the shaft; thence down that face to the shaft and up to the surface. Water must be dealt with in the same way until the faces from the shaft and "break-up" meet one another.

These are not the worst arguments against a top heading. Bearing in mind that a certain thickness of lining and that certain bars with a specified drop will be sufficient, the first length is commenced. Before about three are completed the calculations are found valueless, and that a lining 3 feet thick, bars 2 feet diameter with 18 in. drop are absolutely required to take the weight. Top of heading must be raised 1½ ft. or 2 ft. all through the tunnel despite the increased weight owing to the ground having been previously disturbed.

This raising in wet and heavy ground is exceedingly difficult, and will be found to cost fully 50% of the first cost of the heading. It may be claimed that the heading should be driven high enough at first. In this case if the first calculations are borne out this will entail all the more dry packing to be done between the brickwork and the roof of the mined ground. Again, in driving a top

heading at the outset, considerably stronger timber would be used, as some of it must remain under strain for approximately half the time during construction of tunnel; whereas, the timber used for supporting a top heading driven for each length as it is worked, would only remain understrain about 10 days, and consequently need not be so strong.

If "drawing bars" are used, they are placed under the head-trees of the top heading, the head-trees forming the top timber of the settings placed in this heading to support the ground, until the crown bar is in position and staved, remaining there until the brickwork of the length is keyed. The bars are then drawn, and serve for the next length. The head-trees cannot be extradicted and are lost (which supports the contention that this timber should be no stronger than necessary). In a light tunnel no "drawing bars" are needed, what are called "taking out bar" being used instead. In this case the head-trees can come out with them.

There is always considerable face weight in a length, i.e., pressure tending to shove the face forward into the length, and often causing a good deal of movement, more, of course, near the top than near the bottom of the length. This pressure dislocates the top heading timbers and the settings are found to slightly lean over toward the nearest working face. To keep them up, and the heading open, lining or intermediate settings placed between those originally set will be needed, and also lacing boards spiked from head-tree to head-tree, and from side-tree to side-tree. Even with these precautions a collapse due to this cause is not always averted.

Lastly, a bottom heading has the advantage of becoming a drain for all water above it, and so keeps the work in the top dry. It is better not to drive a top heading unless previously assured that there will be little weight, and that reasonable calculations as to lining bars can be depended upon.

Setting Outlines; Driving Headings, and Fixing Position of Working Faces.—As it is more desirable to drive a bottom heading, let it be supposed that all shafts are sunk to formation level, with a good sump under each with, for example, one shaft at each end and three intermediate shafts placed nearly equidistant.

The centre line must be accurately set out on the surface and permanent points fixed upon it, one on each side of each shaft and on the tangent, if there is a curve. They must be clear of all workings and not disturbed. It is well to suspend two copper wires from the top of either of the shafts, set up the transit over one of the points and sight along to the other across the shaft. Fix two pieces of wood on some convenient part of the headgear transversely, one on each side of shaft, and as far apart as the width of shaft will allow, so that the wires may hang freely from them. Cut a notch in each board in the centre line and suspend the wires in the notches with a 10-lb. plumb-bob. These bobs should swing in a pail of muddy water, or oil, care being taken that the wires are clear of timber, etc. Their line can be transferred to some fixed point on either side of the shaft, or by stretching a fine cord across them, which will be sufficiently accurate for driving 10 yds. of heading on either side. When this length is done more accurate lines are required. The wires are again swung and the transit taken down the shaft. Then, with a plumb-bob attached to a fine line, sight on to the line of the wires as nearly as possible with the eye. Indicate in some clay, put on the ground for the purpose, where this bob drops; set the transit over this mark and sight onto the nearest of the two wires. To provide sufficient light for this work, a hole should be pierced in one of the trunnions and a mirror and reflector placed in it, then, by holding a candle to the end of this trunnion and looking through the eye-piece, the hairs will be visible. If electric lights are used this operation will be facilitated. A convenient method of sighting the suspended wire is to have a piece of white paper held behind it, with a light behind the paper. Set the transit on this wire, then have the wire gently moved to one side and the cross hairs should cut the other wire. If not, then the point in the clay is a little out and the transit must be gently shifted until the wires coincide exactly with the cross hairs of the telescope. The centre line being now on the instrument, an iron staple may be driven into the head-tree of the heading, in the setting next but two to the face. In it file a nick exactly on the centre line, and repeat this on the other side of the shaft, without moving the instrument. By hanging plumb lines in these nicks an accurate line is obtained which will serve for another 20 yards or more each way.

Let every point be put in accurately, whether for permanent or temporary use. If a point is put in just for the time and not secure, it gets worked out of line, it causes no end of trouble and delays for rectification if a great error is produced. Too many "line points" cannot be used, provided they are all correct. Some get moved by pressure, shots, slips, etc. If there are plenty of points, suspend lines to all, and notice if they are in line. Take the line of the majority and immediately obliterate those in error.

Setting out a tunnel requires plenty of patience and perseverance in having everything correct.

If the tunnel is straight, and the heading fairly driven, it is easy to put in the working centre line by dropping a single wire down each shaft and ranging in the true centre already found.

Now set the transit at one shaft, and sight to the next; then reverse to that in the opposite direction. If the cross hairs do not cut on to both wires correctly, halve the error at both shafts, shift the instrument forward, and try the next shaft. Thus all five wires may be put into line. Now fix points in the heading between the wires at, say, every half chain, by driving a staple into the head-tree and filing a nick in it. Verify these points now and then by going over this process, as sometimes the mining operations cause the ground above to settle, shifting these points, and throwing the wires out of line.

The best way of giving lines on a curve is to drop one line down the shaft exactly in the centre, set the instrument in the line tangent to the curve, and let a second wire be dropped in this tangent line. Then, with the transit produce the tangent into the heading, placing points at every half chain, measuring the offsets to the curve from each point. Drive in staples and file nicks as before. Make a neat plan of this, setting out the points plainly, and give it to the foreman-miner, who should be a man of intelligence and able to use it. If a point is blown out by a shot, the foreman can help himself if he understands the plan.

Always set out centre lines with an instrument, for if carried out by rule of thumb, errors which, although not serious, are annoying, creep in, causing loss of time. Besides, if headings driven from opposite faces do not meet well, a "jink" is caused in the line of temporary

rails afterwards laid, and wagons will be continually running off at the jink. In a close heading the derailment of a full wagon is a great source of annoyance.

A bench mark having been established at the bottom of each shaft, by downward measurement, a "brob" should be driven into the timber at rail level and painted. If the tunnel is on a gradient a board about 15 ft. long, with one edge level and the other cut to the inclination of the gradient, should be fixed into position. The gauger can then level from the B.M. until sufficient heading is driven to allow of another B.M. being put in. The bottom of the heading should be kept about 1 ft. above the intended formation level. The size of heading, clear of all timber, should be enough to permit the free passage of a tip-wagon, for as soon as the headings are through, a line of rails will be carefully laid through the entire length of tunnel and connected with the cuttings at either end, and also with the outside works. This road will be commenced for bringing in heavy bars, timbers, bricks, mortar, etc., and for removing the excavated material.

A heading 7½ ft. high and 8½ ft. wide at the underside of the head-tree, and between the side-trees, will be sufficient. While sinking the shafts, etc., a good supply of small timber should be provided for this, averaging from 6 to 10 in. diameter, and also plenty of poling boards from 1 to 1½ in. thick, 6 to 9 in. wide, and about 4 ft. long. If the ground is loose and shaky, a great many such boards will be needed, and as the immediate supply of them direct from a lumber merchant is uncertain, and being without them is as bad as being without bricks and mortar, the lumber should be on hand. To ensure a constant supply for a 1-mile tunnel, at least two circular saw benches should be set up, and driven by the engines working the pits. A great many foot blocks, cleats and wedges will be needed, all of which can be cut by these saws. This sawing should not be done by piece-work; it causes much trouble in measuring the work done, and the miners will constantly come up the shaft for boards and wedges, which will not have yet been measured. The result is that the sawyer's word must be taken as to quantity, as it is impossible for the timekeeper or foreman to be always at hand.

The side-trees, when in position in the heading, should each have a 6-in. "sprag," i.e., they should lean inward to that extent. Hence, if the distance between them at the underside head-tree is 8½ ft. at the bottom of the heading, it should be 9½ ft.

Every side-tree in a heavy tunnel should be set upon a foot block of hard wood about 15 in. square and 3 or 4 in. thick, and placed about 6 in. below the proposed floor of the heading. This gives a wider bearing surface, and prevents the tree from sinking or cutting into the ground. Sometimes the floor of the heading will commence to rise or spring up, owing to the pressure above. If there are any signs of this, every second setting of side-trees, and sometimes every setting, should be placed upon a good square timber or sill, running across the heading from one side to the other, below temporary rail level. The weight on the side-trees keeps the ends of this timber in place, and the weight of the road and passing wagons keeps the middle from rising. Two side-trees and one head-tree, and a sill, when necessary, form a "setting." These settings should be placed at least at yard intervals, the poling board reaching from one head-tree to the other, and overlaping 3 or 4 inches. In soft ground these boards must be placed close together throughout.

[NOTE—Mr. Goodday's article will be continued in an early issue.—Editor.]

CALCIUM CARBONATE IN WATER.

AMONG the papers discussed at the annual meeting in London of the Institution of Water Engineers of Great Britain was one by William T. Burgess, F.I.C., on the solubility of carbonate of lime and its bearing on certain processes for the treatment of water supplies. The following constitutes the dominant features of his address:—

The majority of water engineers have to deal with more or less calcareous supplies, and there are two groups in particular who have to study the matter practically. On the one hand, many are in charge of works where the supplies are softened, the operation being mainly the removal of carbonate of lime, and, on the other hand, there is another group concerned in hardening their soft supplies, usually by the addition of carbonate of lime, with the object of neutralizing acidity and preventing possible action on lead.

The fact that carbonate of lime is such a common ingredient in hard waters was doubtless one of the reasons which made the late Dr. Clark select it as the representative substance in his well-known soap test, and to express degrees of hardness in terms of that carbonate.

Some of the best water-bearing formations are entirely, or largely, composed of carbonate of lime—e.g., chalk, oolite, limestone, etc.—but although waters derived from such areas are always hard from the presence of carbonate, the carbonate of lime itself is really a very insoluble substance in pure water. Many chemists have estimated the solubility, the results varying from 1 to 3 parts per 100,000 of pure water. Careful experiments by the author, using water as pure and free from carbonic acid as possible, have shown that 100,000 parts will only dissolve 1.5 parts of the carbonate.

Carbonic acid is the natural agent which accounts for the carbonate of lime in our water supplies, but it is incorrect to assume that the rain water which falls on calcareous areas carries sufficient carbonic acid to effect the solution. Rain water seldom contains more than 1 part of carbonic acid per 100,000, a proportion quite insignificant towards effecting the solution of such amounts as are found in chalk-derived waters. A much larger amount of carbonic acid comes from the decomposition and oxidation of the organic matters in the soil on which the rain falls, and the examination of water from a percolation gauge having a depth of only 3 ft. of soil-covered chalk has shown that such water may already contain half as much carbonate of lime as is found in water from many deep wells in the chalk. The carbonic acid holds the carbonate in solution as bicarbonate. Water saturated with carbonic acid at ordinary pressure and temperature will take up as much as 100 parts of carbonate per 100,000 of water, but nothing like this amount is ever found in public water supplies. From numerous analyses the author has made it appear that the proportion of carbonate of lime in calcareous waters is seldom over 30 parts per 100,000. (Carbonate of magnesia is much more soluble than carbonate of lime, both in pure water and in water saturated, or partly saturated, with carbonic acid.)

The elimination of the carbonic acid, which is loosely combined with the carbonate to form bicarbonate, will cause the separation of the carbonate of lime. Thus, boiling for some time drives the carbonic acid out of the water, and results in the deposition of the carbonate; the

water is softer after the operation, and on this account the hardness due to carbonate of lime is described as "temporary" to distinguish it from the "permanent" hardness caused by other soap-destroying ingredients which are not affected by boiling. Heat does not drive off the carbonic acid readily, and consequently the boiling process is neither economical nor efficient for softening water. It is not sufficient to heat the water to boiling-point; it must actually boil, and often five minutes' brisk boiling will only reduce the hardness due to carbonate of lime by about 50 per cent. In the ordinary domestic hot-water services to baths, the water rarely reaches boiling-point owing to the circulation, and but little of the carbonate of lime, such as is found in our London supplies, gets deposited in the boilers and pipes. The author has frequently tested the hottest water from bath taps, and seldom found the carbonate hardness reduced by more than one-eighth of the total. If the carbonic acid left the water easily on the application of heat, and thus caused a better separation of the carbonate, the users of calcareous waters would be obliged to have their hot-water boilers and pipes cleaned out at much shorter intervals of time than they do now.

After long storage calcareous waters tend to lose carbonic acid, particularly in open reservoirs where vegetation flourishes. In such cases the carbonic acid is utilized by the plants, and deposition of a certain amount of carbonate takes place, with corresponding reduction of the hardness of the water.

Most calcareous waters contain a little carbonic acid in excess of that in hypothetical combination as bicarbonate, and this excess can be partly removed by agitation with air; the removal of the excess causes a slight separation of the carbonate of lime. This is not a practical method of softening, but the author found that the carbonate hardness of a chalk well water was reduced from 23.5 to 10.4 parts per 100,000 in the course of some months by storage and occasional agitation with air. (Vegetation had no part in the reduction, as the water under experiment was kept in the dark.)

Many chemical substances may be added to water to combine with the carbonic acid, and thus reduce the precipitation of the carbonate; but of all these lime is the cheapest and best.

Removal of Carbonate of Lime from Water by Clark's Lime Process.—As is well known, the hard water is mixed with a proportion of lime water just sufficient to react with the carbonic acid which holds the carbonate of lime in solution; the carbonate originally present, together with that formed by the combination of the carbonic acid and lime, becomes insoluble, and falls out as a fine crystalline precipitate, leaving the water softened. This general statement requires a little qualification, for, as already explained, carbonate of lime has a slight degree of solubility in water entirely free from carbonic acid, the amount being 1.5 parts per 100,000. From this it follows that it is impossible to reduce the carbonate of lime hardness in the most favorable water below that figure—at any rate, by any simple lime process. (As an illustration of how close works practice may approach the theoretical limit, it is, perhaps, worth mentioning that the author has on many occasions found the carbonate hardness of softened water below 2 parts per 100,000.) The carbonate of lime is either allowed to settle down in large subsidence tanks, or, after giving a short time for the reaction, it is filtered off.

Considering, first of all, the method of subsidence in tanks, it is a matter of common observation that the time taken before the water clears is by no means constant. Sometimes the water is bright in six or seven hours, while at other times twelve to fourteen hours elapse before the precipitated carbonate has properly subsided. The reason for this variation, where the conditions are apparently identical, is obscure; but it probably depends on the way in which the lime water and hard water happen to mix, intimate mixture and good agitation favoring the formation of a fine precipitate. Although twelve to fourteen hours is usually sufficient for the subsidence and the production of brilliant water, there is a great advantage in allowing many hours more, for the water, although clear, is often in the condition of a super-saturated solution of carbonate of lime, and from such a solution the excess carbonate, while it does not form a further precipitate, will crystallize out slowly on the sides of the tanks, or, if sent out too soon, in the mains. One of the objects of this communication is to call attention to the fact that the full separation of the carbonate is often a matter which requires a much longer time than is usually supposed. The subject is best illustrated by the results of a few laboratory experiments. In the tests the waters were treated with the proper proportions of lime water to effect good softening, and after the precipitate had subsided, the perfectly clear top was carefully syphoned off at intervals and examined for total carbonate in solution.

A. **Chalk-derived Water.**—Total carbonate hardness in untreated water 22.5 parts per 100,000.

	Total carbonate found in clear water after softening.			
Time of subsidence ..	10 hrs.	25 hrs.	49 hrs	73 hrs.
Total carbonate in clear softened water in parts per 100,000	4.8	3.9	3.6	3.6

B. **Calcareous Water.**—Total carbonate hardness in untreated water 17.6 parts per 100,000.

	Total carbonate found in clear water after softening.			
Time of subsidence..	10 hrs.	22 hrs.	46 hrs.	70 hrs.
Total carbonate in clear softened water in parts per 100,000	3.1	2.8	2.4	2.1

C. **Chalk-derived Water.**—Total carbonate hardness in untreated water 22.4 parts per 100,000.

	Total carbonate found in clear water after softening.				
Time of subsidence..	12 hrs.	24 hrs.	36 hrs.	60 hrs.	84 hrs.
Total carbonate in clear softened water in parts per 100,000	3.7	3.3	3.2	3.0	3.0

A consideration of the above results is quite sufficient to show that even when perfectly clear water is drawn off and pumped to distribution there is more than a probability of the crystallization or separation of a small amount of carbonate of lime in the mains. The longer the time the water is stored before distribution the less the probability of deposit.

The author has made many experiments to ascertain the effect of partial softening in the delayed separation of the carbonate. In the tests recorded below the waters were treated with the correct proportion of lime water (A), and also with smaller proportions to effect less softening (B, C and D).

Calcareous Water.—Total carbonate hardness in untreated water 17.2 parts per 100,000.

Time of subsidence.	Total carbonate found in clear softened water, in parts per 100,000. A	B	C	D
10 hours	3.3	3.8	4.1	5.8
22 "	3.0	3.6	4.0	5.8
34 "	2.6	3.3	3.7	5.7
46 "	2.5	3.1	3.6	5.6
70 "	2.3	3.0	3.5	5.5
94 "	2.1	2.9	3.4	5.4
Total carbonate which separated out after the water had first cleared	1.2	0.9	0.7	0.4

Chalk-derived Water.—Total carbonate hardness in untreated water 20.1 parts per 100,000.

Time of subsidence.	Total carbonate found in clear softened water, in parts per 100,000. A	B	C	D
11 hours	3.4	4.2	5.8	7.2
23 "	3.2	4.0	5.6	7.2
47 "	3.1	3.8	5.4	7.1
71 "	2.2	3.7	5.4	7.1
Total carbonate which separated out after the water had first cleared	0.5	0.5	0.4	0.1

Only one conclusion can be drawn from the above figures, and that is that the more perfectly the water is softened the greater is the necessity for giving it a long period for subsidence, and it is the irony of fate that at works where the most efficient softening is aimed at the probability of deposition of carbonate in the mains is greater than at places where partial softening is the rule.

With regard to softening works where filtration is relied on for the removal of the carbonate, the question arises: Is such filtered water more or less liable to form an after deposition of carbonate than the clear water obtained from subsidence water? In the author's opinion the liability is certainly not greater.

At what may be termed filtration works the hard water and the lime water are intimately mixed in their proper proportions at once; this favors the formation of a very fine precipitate, a large portion of which remains suspended in the water during the short time, usually about one hour, until the turbid water reaches the filtering cloths, where the precipitate is arrested. The surfaces and pores of the cloths soon become coated with the fine crystalline precipitate, and in making its way through what is practically a porous surface of carbonate of lime crystals, the water tends to part with any excess carbonate which it really holds in solution. This action compensates for the shorter time taken in the filtration process, and thus places the clear products of the two systems nearly level with regard to their liability to form deposits in mains and pipes.

After all, it may be argued that at well-conducted works not much trouble arises from deposition in the mains, but the author desires to point out that it may be practically prevented by simple chemical means. The addition of a very small amount of acid to the treated water from either subsidence or filtration works will entirely prevent the after-separation of the carbonate, and carbonic acid is probably the cheapest and easiest applied. In this connection members may be reminded that in the rapid softening process of Archbutt and Deeley,* in order to prevent the after-separation of carbonates from the treated water, the water leaving the softening tanks is "carbonated" by the introduction of air charged with carbonic acid drawn from the chimney of a coke stove. The author has reasons for thinking that the application of such "carbonating" at ordinary softening works would often be useful to engineers. The introduction of a very small proportion of carbonic acid, even as little as 0.3 part per 100,000, is sufficient to check or stop the after-deposition of carbonate, and at places where smokeless, or nearly smokeless fuel is burned there is no reason why the ordinary flue gases, after washing, etc., should not be utilized. At subsidence works the possible output might be greatly increased, for with slight "carbonating" the water could be drawn off and pumped to distribution, or reservoirs, immediately after it had first cleared. In carrying out any experiments it would be necessary to proceed with caution, because the introduction of too much carbonic acid might lead to other troubles, but the author believes that the complete control of carbonating plant would not be difficult.

Introduction of Carbonate of Lime Into Water: Hardening.—The amount of carbonate that a soft moorland water is capable of taking into solution is strictly limited, and is governed by the degree of acidity, which can, of course, be determined by analysis. Moorland waters always contain some free carbonic acid, and often, in addition, other acid or acids. If the free acid is simply carbonic acid, any proportion less than 0.7 part per 100,000 will only affect the solution of 1.5 parts of carbonate of lime, the same proportion as pure water will take up. With greater amounts of carbonic acid the proportion capable of passing into solution is exactly that which corresponds to the possible formation of bicarbonate; thus a soft water containing 1 part of carbonic acid will dissolve 2.4 parts of carbonate of lime. When the water contains, in addition, another free acid, this will determine the solution of a certain amount of carbonate and liberate a corresponding quantity of carbonic acid, which can take up a further proportion in the form of bicarbonate. Knowing the amount of acidity in the water, the chemist can therefore calculate the maximum proportion of carbonate which is possible of solution.

The carbonate is usually applied to soft waters in the form of powdered chalk, or whitening, and if the question of cost could be neglected, theory suggests that the material should be in the finest possible state of division. The fine particles expose a great surface to the water, and have the advantage of remaining in suspension for a long time. This is not altogether a matter of theory, for the author's laboratory experiments with carbonate in various states of division show the advantage of using very fine particles.

The president was kind enough to furnish the author with samples of untreated and treated waters from the Wakefield Corporation works. Members who visited the works this year will remember that the water is treated with both carbonate of lime and lime water in order to harden it slightly. The author treated the raw water with a considerable excess of pure carbonate of lime for two days in a closed vessel, and afterwards estimated the amount which had passed into solution. The result was 3.4 parts of carbonate per 100,000, and this figure was exactly the proportion which was indicated as possible

*Journal of the Society of Chemical Industry for 1891, page 511.

from the analytical determinations of the original acidity of the water. The author found that combined carbonate and lime treatment employed at the works had increased the hardness by the equivalent of 2.5 parts per 100,000, and that the process had been so carefully adjusted that the product contained neither free lime nor free carbonic acid. The above notes show what can be done in the way of hardening by carbonate of lime, and indicate the limits of the process.

"Excess Lime" Method of Sterilizing Water.—In the Eighth Research Report to the Metropolitan Water Board, Dr. Houston gave an account of experiments demonstrating the sterilization of raw Thames water by treating it with lime considerably in excess of that necessary to effect softening alone. The treatment of soft waters was also dealt with, and in the Ninth Report (April, 1913), this matter is followed up and notes are given showing the practical sterilization of a "very soft, peaty river water" by small quantities of lime. Experiments are quoted showing that purposely polluted water could be brought to a reasonable standard of bacteriological purity by the germicidal action of 2 parts, or even 1 part, of lime per 100,000 of water, the former proportion being effective in forty-eight hours and the latter in 144 hours. With regard to the free lime left in the water, Dr. Houston states that, if thought desirable, it could be removed by the addition of bicarbonate of soda. Dr. Houston recognizes that there would be cheaper methods of neutralizing the excess of lime "although none perhaps so apparently free from any disadvantages."

The expense of the suggested treatment will be better understood when it is explained that any free lime left in solution will require to neutralize it exactly three times its weight of bicarbonate of soda, and as this substance costs about £6 a ton, or roughly six times as much as lime, it follows that the expense of neutralizing will be 18 times the cost of the free lime left in the water after sterilization. However, neglecting the question of cost, the method may be examined from the chemical point of view. The reaction which takes place is—

$$Ca(HO)_2 + 2NaHCO_3 = CaCO_3 + Na_2CO_3 + 2H_2O.$$

Hydrate of lime + Bicarbonate of soda = Carbonate of lime + Carbonate of soda + Water

The solubility of the carbonate of lime formed has an important practical bearing on the possibilities of the process, and the matter is best illustrated by giving the results of some experiments. Samples of pure water, free from carbonic acid, were treated respectively with lime in the proportions of 1, 2 and 3 parts per 100,000, and were afterwards "neutralized" with 3, 6 and 9 parts of bicarbonate of soda. In the case of the experiment with 1 part of lime + 3 parts of bicarbonate of soda no precipitation or separation of carbonate of lime occurred, even after keeping the samples three days; but in the other two cases the precipitate formed slowly, and then settled down in about twelve hours, leaving the water perfectly clear and brilliant; but these waters were left in the condition of supersaturated solutions, from which the carbonate slowly crystallized out on the sides of the containing vessels, and were thus in states favorable for making deposits in mains. Further, it was found that the waters which were originally treated with 2 and 3 parts of lime, and neutralized with bicarbonate of soda, deposited, in the secondary separation, larger amounts of carbonate than might have been expected after allowing for the known solubility in pure water. The experiments were repeated several times, but always with the same results, and further tests established the fact that carbonate of lime is really more insoluble in water containing a little carbonate of soda than it is in pure water. (Thus, in water containing 3 parts of carbonate of soda, carbonate of lime is only soluble to the extent of 0.27 part per 100,000, as against 1.5 parts per 100,000 in pure water.)

It is fairly evident that if the free lime to be neutralized by bicarbonate of soda in the "excess lime" process exceeded 1 part per 100,000, special precautions would have to be taken, otherwise considerable deposits of carbonate of lime might readily occur in the mains.

THE CONSTRUCTION OF A REINFORCED CONCRETE RESERVOIR.

THE accompanying illustrations and the following data respecting the design and construction of a reservoir and coagulation plant for the Anheuser-Busch Brewery at St. Louis, Mo., are from a paper to be read by Mr. Ed. Flad, M. Am. Soc. C.E., at the February 4th, 1914, meeting of the society. His paper includes a short explanation of the waterworks system of the company, the system having a capacity of over six million gallons per day, this water supply coming from the Mississippi River through two 20-in. cast iron intake pipes, being syphoned into intake wells, pumped into settling tanks, and clarified by chemical coagulant and rapid filtration before distribution. The chemical treatment was adopted in 1901, several years before the City of St. Louis itself began the treatment of water supply.

The low-service pumps of the system are in a brick pit, 30 ft. in diameter and 40 ft. deep. There are three centrifugal pumps having a combined capacity of 13,000,000 gal. per day, and one triplex, direct-acting pump having a capacity of 2,000,000 gal. per day.

There are two steel settling tanks, 75 ft. in diameter and 28 ft. high, one circular concrete reservoir approximately 150 ft. in diameter and 30 ft. deep, and one rectangular covered reservoir having a capacity of about 1,000,000 gal.

The filter plant comprises six Jewell filters, circular in plan, each 16 ft. in diameter, and three Reisert filters, recently completed, which are rectangular in plan, each being approximately 34 by 15 ft.

Chemical Treatment.—The water is settled by adding sulphate of aluminum (alum) and lime. A special three-story reinforced concrete building is provided for storing and preparing the chemicals.

The hopper for storing the lime is 36 by 9 by 14 ft. high, and has a capacity of 90 tons. It is placed in a pit so that it can be filled directly by shoveling from the cars. An electric elevator conveys to the third floor the hand-cars containing the lime or alum.

The alum is dissolved in a concrete tank, and is fed to the water by gravity. This alum tank has three rectangular divisions, each 10 by 7 by 5 ft. deep. Each division is charged with from 500 to 2,000 lb. of alum which is dissolved in water. It requires from 2 to 5 hours to dissolve one charge. The lime is slacked in iron tanks on the third floor. These tanks are rectangular, 12 by 12 by 7 ft. deep, with sloping bottoms. A false perforated bottom is provided at a depth of 30 in., on which the lime is placed and partly submerged in 1 ft. of water. After slaking, which requires about 1 hour, the attendant stirs the mixture, which passes readily through

the perforated bottom and into the lime tanks below. This milk of lime is stored in three vertical cylindrical iron tanks, 12 ft. in diameter and 18 ft. high, with conical bottoms. One charge of lime consists of from 2,000 to 6,000 lb., and the tank holds about 10,000 gal. of water, giving a 2½ to 7% solution. In these tanks the milk of lime is kept agitated by compressed air admitted at the bottom through a small perforated pipe.

The flow of both the alum and lime solutions is regulated by standardized orifices operating under fixed heads. The milk of lime is pumped into the supply pipe or settling tanks by a centrifugal pump. As a general rule, the lime is added to the water as it enters the first settling tank, and the alum as the water enters the second settling tank.

Consumption.—The maximum consumption of water during the summer is about 6,000,000 gal. per day, for which at times, 1,600 lb. of alum and 5,600 lb. of lime are required, or about 2 grains of alum and 7 grains of lime per gallon of water.

The water is used for boiler purposes, for condensing and cooling in connection with the ice machine, as well as for washing barrels, bottles, etc. It is not used in brewing beer, partly because of the natural prejudice against water taken from the river below the outlet of the large city sewers.

Reinforced Concrete Reservoir.—Reverting now to the reinforced concrete reservoir completed: After due consideration of the various possibilities as to the shape and location of the reservoir, a circular shape was decided on, and the diameter was made as large as the available space permitted. The elevation of the top was fixed by that of the water in the old settling tanks, which operate in series with the new reservoir; and the bottom was placed sufficiently low to pass below the fill of cinders and rubbish, and rest on the river silt.

Estimates were made of the comparative cost of a steel tank and a reinforced concrete reservoir. Exclusive of the foundations, pipes, gate-house, and accessories common to both designs, the steel tank was estimated to cost $32,000, and the reinforced concrete reservoir, $30,800. The reinforced concrete reservoir was supposed to have some advantage, being a more permanent form of construction and not requiring painting, and perhaps a desire to follow the latest fashion had a minor influence; at all events it was decided to use reinforced concrete.

The reservoir has vertical sides and is 153 ft. 6 in. in diameter at the top and 35 ft. deep at the centre. The side-wall extends 25 ft. 6 in. above the ground. The capacity is approximately 4,250,000 gal. There is a central partition, consisting of a 4-in. reinforced concrete wall, with buttresses, which starts at one side of the reservoir and passes diametrically across to within 14 ft. of the other side. The object of this partition is to make the entering water circulate around the reservoir before reaching the outlet. The diameter of the intake and outlet pipes is 30 in., and that of the waste pipe 24 in. The outlet pipe has a float and a hinged joint, so that water is always taken from near the surface. The valves controlling the flow are in a gate-chamber outside the reservoir.

Foundation.—The foundation is a 12-in. layer of concrete resting directly on the river silt and reinforced, in two directions at right angles, with 1 in. square bars, 2 ft. from centre to centre, making ½% reinforcement each way.

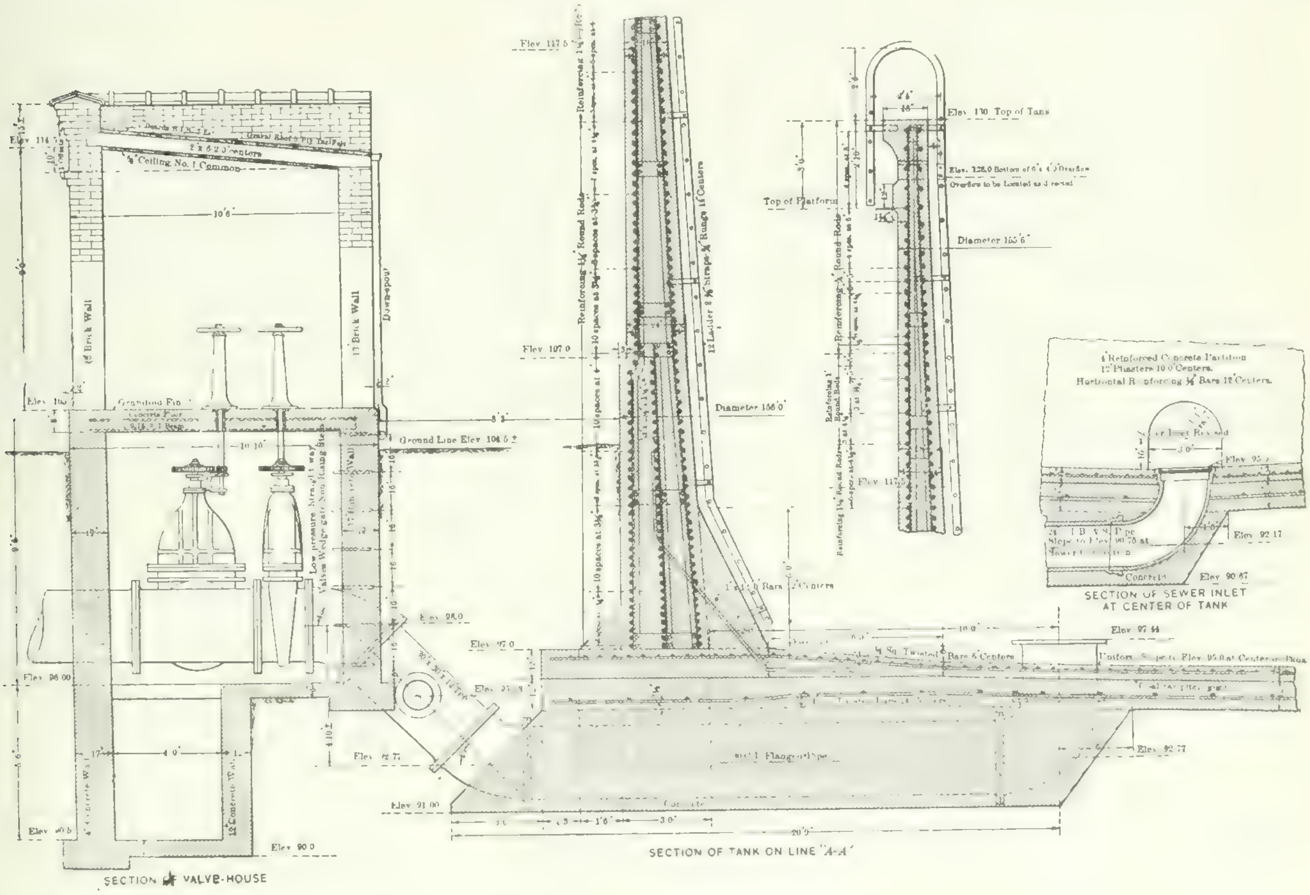

Fig. 1.—Section Details of Settling Tank.

On top of this foundation rests the bottom of the reservoir, which is 6 in. thick and reinforced in a manner similar to the foundation, except that the bars are ½ in. square and 6 in. from centre to centre.

The top of the foundation was coated with a thin layer of coal-tar, the object being to provide for expansion and contraction of the bottom independent of the foundation.

Side-Walls.—The thickness of the concrete side-walls is 7 ft. 6 in. at the base, 2 ft. 5 in. at the ground line, and 12 in. at the top. The pressure of the water is carried by hoop tension, the side-walls being reinforced circumferentially with corrugated round bars, under the assumption that the concrete carries no tension. There are three lines of 1¼-in. round bars at the bottom and two lines of ¾-in. round bars at the top, the sections and spacing being varied from bottom to top to correspond with the pressure. It was intended to allow a stress of 15,000 lb. per sq. in. on the bars. Owing to an error in the calculation, which, happily, was on the safe side, an excess of steel was used, making the stress per square inch somewhat less than originally contemplated.

The thickness of the concrete wall was fixed at each point so that the concrete would not be stressed more than 290 lb. per sq. in., under the assumption that no vertical cracks would develop under this tension. Assuming the modulus of elasticity of steel at 30,000,000 and concrete at 3,000,000, the actual maximum stress, if no vertical cracks develop, will be 2,900 lb. per sq. in. of steel and 290 lb. sq. in. of concrete.

The following formulas were used in determining the dimensions and spacing of the steel bars and the thickness of the concrete:

A = Area of bars, in square inches per foot of height of wall;

D = Vertical distance, in inches, between two layers of bars at the point selected;

T = Thickness of concrete wall, in inches, at the point selected;

p = Water pressure, in pounds per square foot, at the point selected;

r = Radius of reservoir, in feet;

s = Stress in steel, in pounds per square inch, allowed, under the assumption that the concrete carries no tension;

c = Stress in concrete, in pounds per square inch, allowed;

a = Area, in square inches, of steel in each layer.

The area of the bars required per foot of height of wall is

$$A = \frac{p\,r}{s}$$

The vertical distance between the layers of bars is

$$D = \frac{12\,a}{A}$$

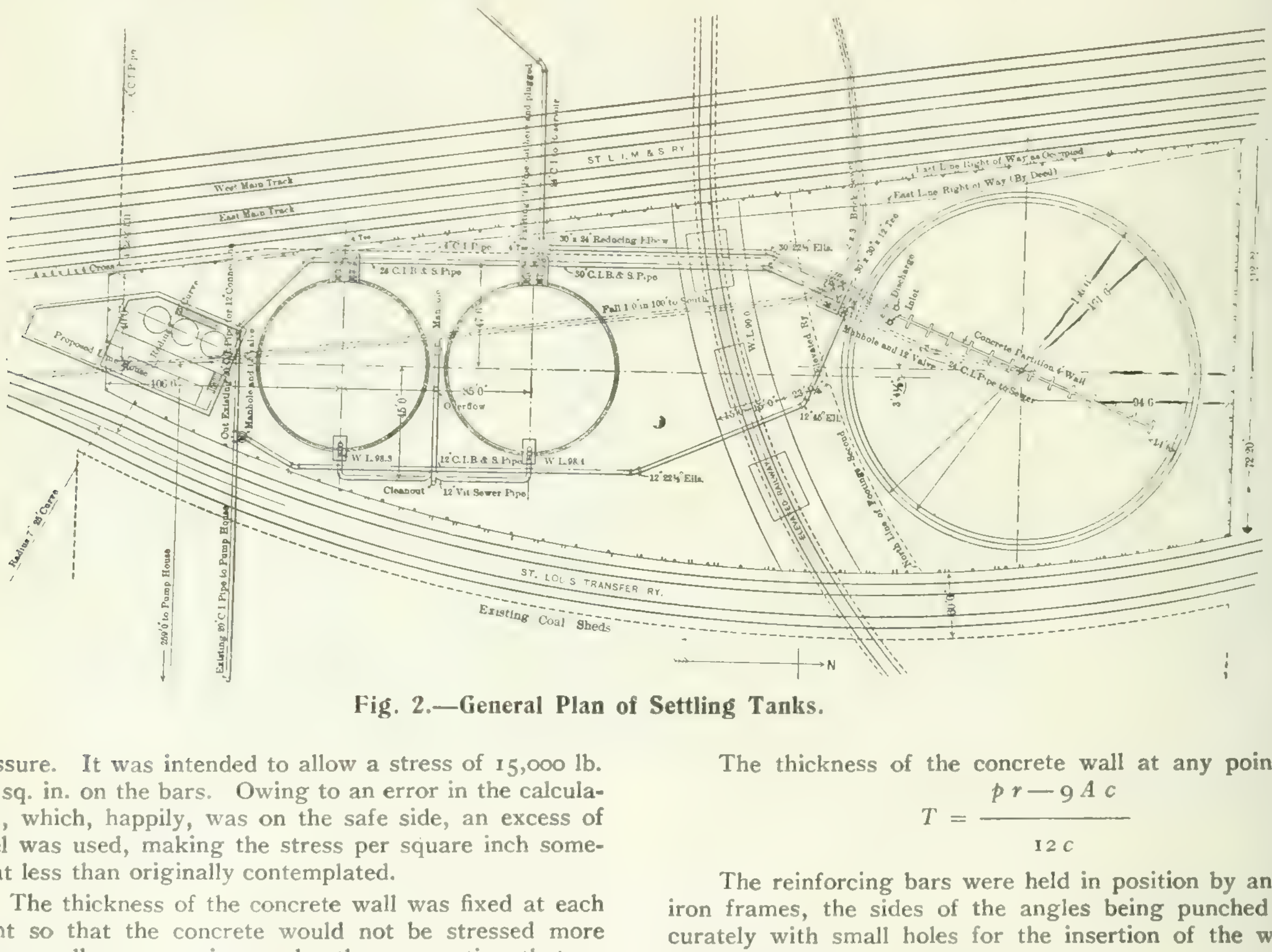

Fig. 2.—General Plan of Settling Tanks.

The thickness of the concrete wall at any point is

$$T = \frac{p\,r - 9\,A\,c}{12\,c}$$

The reinforcing bars were held in position by angle-iron frames, the sides of the angles being punched accurately with small holes for the insertion of the wires which tied the bars to the frame.

Splices.—The circumferential bars were in lengths of from 50 to 55 ft., and were spliced by lapping forty diameters and attaching two Crosby clips at each lap. The strength of this joint was tested by making up sample joints and pulling the bars in a testing machine. Two tests were made on each diameter of bar used, one with bars and clips without any mortar, and the other with the same joint embedded in cement mortar of the same mixture as that used for the walls of the reservoir.

The tests showed that the presence of the mortar did not add materially to the strength of the joint, as it failed either by slippage or by breaking off the clip. The first sign of slippage occurred at a stress of from 18,000 to

35,000 lb., and the ultimate strength of the joint varied from 25,000 to 75,00 lb.

Table I. gives the results of the tests.

Table I.—Tests of Bars.

Kind of bar.	Began slipping.	Broke at.
*1 ¼-in. round bar, plain......	....	75,600 lb.
† " " " with mortar	....	40,500 lb.
1 ⅛-in. round bar plain	37,400 lb.	....
" " " with mortar	32,200 lb.	32,200 lb.
1-in. round bar, plain	35,000 lb.	....
" " " with mortar..	25,600 lb.	25,600 lb.
¾-in. round bar, plain	27,300 lb.	30,000 lb.
" " " with mortar..	26,400 lb.	26,400 lb.

*1-in. slip at 18,000 lb.
†Mortar broke at 29,000 lb.

Forms.—The forms for the side-walls were built up of ⅞-in. tongued and grooved flooring, with 2 by 6-in. vertical studs about 2 ft. from centre to centre. The studs on the opposite sides were fastened together with iron wire passing through the forms. These wires were approximately 2 ft. apart horizontally and 4 ft. vertically.

The concrete was placed in the forms with a tower and dump cars running on a circular track.

Arrangements for Washing Out.—The bottom of the tank slopes toward the centre from all sides, the 24-in. waste outlet being at the centre. The slope toward the centre could not readily be made more than 2 in 75, being limited by the depth of the sewer which was already built. In order to facilitate the removal of sediment, therefore, the bottom was laid out in a series of star-shaped mounds, as indicated in Fig. 3, each mound draining into a shallow gutter. Hose connections furnish water under pressure for cleaning out.

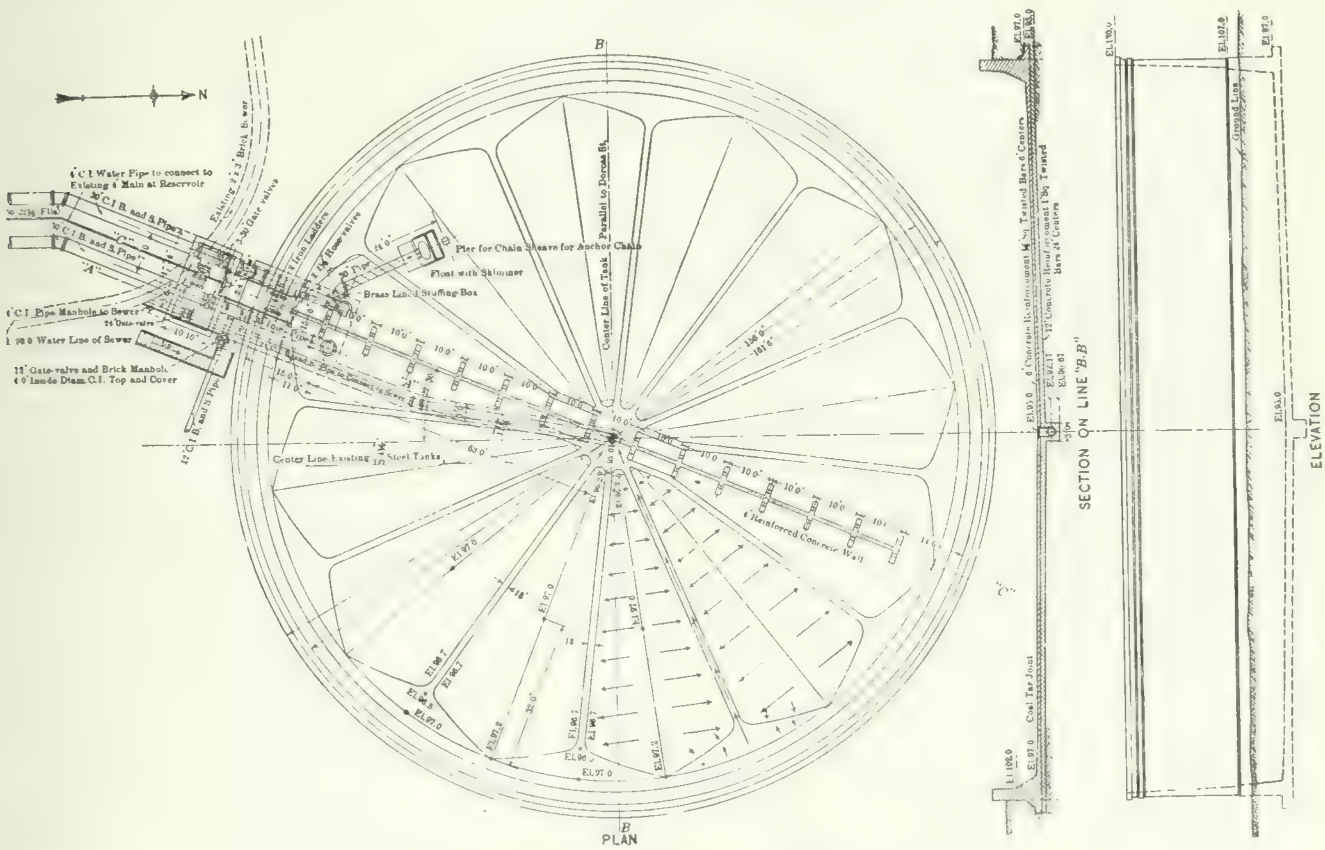

Fig. 3.—Foundation Plan of Settling Tank.

At the junction of the side-wall with the bottom, knee-bars are provided to reinforce this connection. These bars are 1 in. square and 12 in. from centre to centre.

Mixture.—The concrete in the walls and bottom is a mixture of 1 part cement, 1½ parts sand, and 3 parts limestone screenings run through a ¾-in. mesh screen, with the addition of 10½ lb. of Shamrock waterproofing to each barrel of cement. The composition of this water proofing is approximately as follows:—

Silica	60.0	per cent.
Alumina	15.0	" "
Lime	6.5	" "
Oxide of iron	1.5	" "
Combined water	10.0	" "
Gelatinous material	7.0	" "

This material cost 73½ cents per bbl. of cement.

Bond in Concrete.—Special precaution was taken to obtain a good bond between the successive layers of concrete. The old surfaces were scrubbed with brushes and a stream of water. In addition, 6-in. strips of corrugated plates, about 1/16 in. thick, were placed vertically in the joints. In spite of these precautions, when the reservoir was filled, small leaks developed along most of the joints, and efflorescence was quite extensive. These leaks appear to be closing up gradually, and it is probable that in the course of time they will disappear entirely. The intention, however, is to empty the reservoir and treat the joints with some waterproofing compound.

After completion the outside of the wall was rubbed with carborundum blocks and brushed with cement mortar.

The reservoir was designed by the writer's company, and was built under contract by the Fruin-Colnon Con-

tracting Company. The cost, including pipes and accessories, was approximately $52,000. The unit prices and total cost of the various classes of work were as follows:

Excavation, 7,801 cu. yd. at $0.80	$ 6,240.80
Plain concrete, Class A, 58.2 cu. yd. at $4.00	232.80
Plain concrete, Class B, 281.3 cu. yd. at $5.00	1,406.50
Reinforced concrete, 12-in. base, 759 cu. yd. at $5.00	3,795.00
Reinforced concrete, 6-in. bottom, 473.1 cu. yd. at $8.00	3,784.80
Reinforced concrete side-walls, 1,178.3 cu. yd. at $11.00	12,961.30
Reinforced concrete partition, 120 cu. yd. at $20	2,400.00
Reinforcing bars, 582,668 lb. at 1¾ cents	10,196.69
Clips for reinforcing bars	650.00
Ladders and angle-iron supports	852.16
Cast-iron pipes and valves	7,283.00
Gate-house	1,200.00
Miscellaneous	844.59
Total cost	$51,847.64

RAILWAY DEVELOPMENT IN 1913.

A FEW figures showing the extent of Canadian railway development during 1913, appear below. Those relating to single tracking do not take into account a vast amount of extension work that is in the preliminary stage, but refer entirely to lines upon which steel has been or is being laid.

Single Track.	Miles.
Algoma Central & Hudson Bay—In Ontario, one mi. north of Oba to Hearst	49.47
Algoma Eastern—In Ontario, from end of track to Little Current on Manitoulin Island	6.55
Campbellford, Lake Ontario & Western (Can. Pac.)—Glen Tay, Ontario, to Agincourt	182.30
Canadian Northern—British Columbia, 6.07 mi.; Alberta, 256.89 mi.; Saskatchewan, 166.82 mi.; Manitoba, 65.66 mi.; total	495.40
Canadian Northern Ontario (Can. Nor.)—Quebec, 8.00 mi.; Ontario, (between Ottawa and Port Arthur), 536.00 mi.; (between Sydenham and Ottawa,) 36.00 mi.; total	580.00
Canadian Northern Pacific (Can. Nor.)—British Columbia, Hope to Cisco, 62.00 mi.; Kamloops north to Cottonwood, 123.00 mi.; Westminster to Steveston, Lulu Island, 12.00 mi.; between Cisco and Kamloops, 9.00 mi.; total	206.00
Canadian Pacific—In Manitoba, Snowflake west 10.00 mi.; Virden branch between Virden and McAuley, 23.00 mi.; between Boissevain and Lauder, 28.80 mi.; in Saskatchewan, Estevan northwest, 54.5 mi.; Kerrobert northeast, 36.10 mi.; between Swift Current, Sask., and Bassano, Alta., 60.8 mi.; between Weyburn, Sask., and Stirling, Alta., 162.00 mi.; in Alberta, Suffield southwest, 32.3 mi.; between Gleichen and Shepard, 25.00 mi.; on Alberta Central branch, 40.20 mi.; Lacombe east, 12.00 mi.; in British Columbia, on Kootenay Central 63.5 mi.; on White-water-Kaslo line, 16.00 mi.; total	574.20
Esquimalt & Nanaimo (Can. Pac.)—McBride Junction to Little Jualienne river	8.50
Fredericton & Grand Lake Coal & Railway (Can. Pac.)—In New Brunswick, Mile 11 to Mile 23	12.00
Grand Trunk Pacific—In Saskatchewan, Cut Knife branch, 30.00 mi.; Biggar-Calgary branch, 67.00 mi.; Prince Albert branch, 8.00 mi.; Moose Jaw northwest branch, 52.00 mi.; Regina Boundary branch, 48.00 mi.; in Alberta, Tofield Calgary branch, 36.00 mi.; in British Columbia, west of Yellowhead, 122.00 mi.; and east of Prince Rupert, 117.00 mi.; total	480.00
Hudson Bay—Between The Pas, Man., and Port Nelson	100.00
Intercolonial—Georges river, N.S., to Sydney mines	8.80
Interprovincial & James Bay Ry. (Can. Pac.)—Lumsden's Mills, Que., north	10.00
Kettle Valley—In British Columbia	80.00
National Transcontinental Railway—In province of Quebec, 88.26 mi.; Manitoba, 2.22 mi.; total	90.48
Pacific Great Eastern—Between North Vancouver, B.C., and Dundrave, 4.50 mi.; between Newport, B.C., and Cheakamus, 13.50 mi.; total	18.00
Quebec Central—St. Sabine, Dorchester county, to St. Camille, Bellechase county	5.00
Reid Newfoundland Co.—In Newfoundland, Trepassey branch, Biscay Bay to Trepassey, 5.00 mi.; Carbonear to Bay-de-Verde, 53.00 mi.; Goobies to Black River, 15.00 mi.; extension Heart's Content branch to Heart's Content, 1.00 mi.; total	74.00
St. John & Quebec—Between Centerville, N.B., and Gagetown	90.00
Sydney & Louisburg—Waterford Lake, N.S., to Victoria Mines, 1.00 mi.; Morien Junction to Morien Village, 2.00 mi.; total	3.00
Temiskaming & Northern Ontario— Porquis Junction, Ont., to Iroquois Falls	7.25
Vancouver, Victoria & Eastern (Gt. Nor.)—Between Kilgard, B.C., and Sumas Landing	5.05
Total	3,086.00

The following figures give in detail the double tracking that was laid during 1913, or was nearing completion at the close of the year:

Canadian Pacific—Farnham, Que., to St. John's, 13.20 mi.; Agincourt, Ont., to Leaside Jct., 6.20 mi.; Islington, Ont., to Guelph Jct., 29.20 mi.; Azilda, Ont., to Cartier, 9.50 mi.; Hemegos, Ont., to Devon, 12.40 mi.; Ester, Ont., to Shumka, 32.90 mi.; Tarpon, Ont., to Mobert, 20.2 mi.; Navilus, Ont., to Port Arthur, 1.60 mi.; Semlin, Ont., to Paysiplate, 15 mi.; Gravel, Ont., to Dublin, 11 mi.; Bergen, Man., northeast, 20 mi.; Kemmay, Man., to Virden, 39 mi.; between Whitewood, Sask., and Grenfell, 8 mi.; Indian Head, Sask., to Regina, 42.00 mi.; Regina, Sask., to Pasqua, 34.80 mi.; Caron, Sask., to S. Current, 94.80 mi.; Ruby Creek, B.C., to Westminster Jct., 64.4 mi.; total	454.30
Toronto, Hamilton & Buffalo—Welland, Ont., to Fenwick	5.91
Vancouver, Victoria & Eastern—Ardley, B.C., to Still Creek	7.12
Total	467.33

A comparison of mileages of single tracking in Canada and the United States during the past 10 years is as follows:

Year.	Canada.	United States.
1904	316	3,832
1905	1,181	4,388
1906	1,007	5,623
1907	976	5,212
1908	1,249	3,214
1909	1,488	3,748
1910	1,844	4,122
1911	1,898	3,066
1912	2,232	2,997
1913	3,086	3,071

The Panama Railroad is now engaged in building a concrete sea wall along the front of the fill between the fire station at Cristobal and the end of the mole for the new piers, to be used by the buildings of the steamship companies. The total length of the wall will be about 350 ft. It is composed of concrete cubes, one yard on a side, which are laid in brick style and faced above the water line with a wall of concrete one foot thick.

COAST TO COAST.

Paris, Ont.—Hydro-Electric light was used in Paris for the first time on January 8th.

Nelson, B.C.—The plant of the Nelson Coke and Gas Company is being operated by the municipality.

Vegreville, Alta.—The main street of Vegreville is now illuminated by the town's recently discovered utility, natural gas.

Belleville, Ont.—The new branch of the C.P.R., known as the Campbellford, Lake Ontario, and Western Railway, which will connect Toronto and other Lake Ontario points with Belleville, will be opened for traffic shortly. The line runs between Agincourt and Glen Tay, a distance of 182 miles.

Montreal, Que.—The Intercolonial Railway of Canada has under way the following new construction: Nelson, N.B., to Derby Junction, diversion of line, 2.67 miles; St. Romuald, Quebec, to Chaudiere Junction, double tracking 3.75 miles; Pt. Tupper, N.S., to Sydney, N.S., grade revision, 91 miles; Oxford Junction, N.S., to Painsec, N.B., double track, 73.7 miles; Halifax Ocean terminals; passenger station at Sussex, N.B.; automatic blocks from Halifax, N.S., to Windsor Junction, 13.9 miles; from Moncton, N.B., to Painsec Junction, 7.2 miles; from St. John, N.B., to Hampton, N.B., 22 miles; and a line from North Sydney, N.S., to a point near Leitches Creek, 4.3 miles.

Vancouver, B.C.—Some indications that a regular service will be commenced next year on the P.G.E. railway north of Newport are an order recently placed by the company for 150 steel freight cars to be delivered at Newport during the months of March, April, and May next; the possible issue of an interim order by the provincial department of railways at an early date permitting the P.G.E. to operate trains over the completed portions of the line north of Newport in order to transport settlers going into the interior; the fact that steel rails sufficient to lay 30 miles of track are now being delivered at Newport, and that these are to be distributed along the new line early in the spring; and, finally, track has been laid 13 miles north of Newport and grading has been finished for a distance of more than 150 miles from the Pacific terminals, being well advanced beyond Lillooet.

Montreal, Que.—To guard against a subsidence of the soil, which might occur when the frost leaves the ground at any point where excavation has approached too closely to the base of the conduit, carloads of stone are being hauled to the place where the break occurred, which will be used to strengthen the aqueduct bank. A cribwork will be built along the conduit at a distance of a few feet; and after the crib has been filled with stone, earth will be used to fill in the space between the aqueduct and the crib. This work will form part of the programme for protection against water famine in case of emergency. The tapping of the Lachine Canal, the work for which is announced in the *Construction News* columns of this journal, is another phase of the same scheme.

Victoria, B.C.—Though about $2,000,000 of the sum of $9,682,600, appropriated last year by the Provincial Public Works Department, has not yet been spent, the amount of new construction which has been undertaken in public buildings, roads, bridges, wharves, etc., has exceeded greatly that of any previous year in the history of the Provincial Government. The mileage of new roads constructed amounts to over 700, and the mileage on which the department has been engaged, including the work done in repairs and improvements, amounts to over 12,000. Prominent among these roads is the Banff-Windermere highway, on which 16 miles of ungravelled roadbed have been constructed during the past season; and on the transprovincial road, at least 20 miles have been constructed through an abnormally difficult section. At Strathcona Park, under the supervision of Col. Thompson, Messrs. Casey & Lewis have cleared and grubbed 7.25 miles, which is now ready to grade, and have also built a permanent bridge. A large number of important bridges, from time to time noted in *The Canadian Engineer*, have been completed and a number are under construction at the present time. In view of the fact, however, that a large number of buildings cared for by last year's appropriations have not been completed, and also of the general relaxation in building activity, it is probable that the amount to be devoted to public works during the coming year will not approach the record sum expended last year.

Moose Jaw, Sask.—The total expenditure for the work carried out by the civic engineering department in 1913 was $378,059.13. Out of an estimated expenditure of $32,000 for the city engineer's office, when an expenditure of $18,761.26 was deducted for salaries and purchase, there was left a balance of $13,238.74. The total expenditure for the year on contracts covering the work on the high pressure dam, 11th Avenue subway, high pressure mains, sidewalks, curbs and gutters, Algoma Avenue sewer and water extensions, River Park bridge and abutments, was $212,86?.12. The only bridges constructed were those over the high pressure dam on Manitoba street east, and the park bridge over the Moose Jaw river. In the sewer and water extension branch of the department, the annual report shows that 2,139 houses in Moose Jaw are now connected with the mains and sewers. Also in the street cleaning department, an expenditure of $9,600 has sufficed to keep in excellent condition a certain area of paved streets; and the report advises that by increasing the area, the cost could be lowered proportionately. Finally, the water supply of the city, it is stated, is in better condition than ever before; and there is now no danger of shortage during the dry months. There is kept in the reservoirs a supply of 37,990,000 gallons, to which another 30,000,000 gallons can be added at will. Realizing that steps should be taken to increase the water supply to keep pace with the increasing population, the commissioners have investigated the possibility of utilizing the water in the Moose Jaw river and have obtained the consent of the government to proceed with the work. They recommend, therefore, in their report, that particulars as to cost be obtained.

Vancouver, B.C.—The park scheme for some time being planned by park board officials, under the guidance of Park Superintendent W. S. Rawlings and Engineer A. S. Wootten, embraces the development of the point of land in the old C.P.R. hotel site as a picnic ground, the laying out of the parks adjacent to the beach, and the building of a permanent bath-house. The park officials believe that the whole improvement could be completed for $150,000, an equal amount of this being expended each year for the next four years. The plan provides also for the construction of a pier, which would cost probably $75,000; but it is not proposed to build this until necessary. A rearrangement of the car tracks of the C.P.R. operated by the B.C. Electric Railway will have to be made; and several new streets will also be laid out and approaches will be boulevarded so as to form a chain from Stanley Park and English Bay across the proposed Burrard Street bridge and out to Point Grey. The seawall will be constructed of rock taken from the foreshore, to be used as a facing, and to be backed by concrete. Towards the north end, it will be about 4 feet in height, increasing to about 10 feet towards the west; and, at intervals, there will be shelters and steps down to the beach. It will provide for a 40-foot promenade of asphalt with ornamental lighting standards every 75 feet along the edge. The bath-house will be built on the pivotal point of the scheme, equidistant from each end of the promenade; and will harmonize with the

construction of the embankment. The seawall is expected to cost about $30,000 and the bath house an equal amount. Many changes and improvements are planned for the grounds surrounding the beach, chief among which is a fill of 2 to 4 ft. that will be necessary immediately east of the northern portion of the beach. Though the board will be forced to forego much of the work this year, it will commence the clearing up of the west end of the beach, now strewn with rocks, and the piling up of those rocks preparatory to building the seawall at that section. The filling of the other section of the park, now undeveloped, must be proceeded with before permanent improvements can be performed there; and for this work, the park board expects to get the sand to be dredged out of English Bay in connection with the harbor work in False Creek.

PERSONAL.

JAMES E. WILSON, superintendent of the sewer department for the city of Calgary, has recently tendered his resignation. Mr. Wilson is leaving the city's service to engage in private contracting.

E. A. CLEVELAND, of Cleveland & Cameron, Vancouver, B.C., gave an illustrated lecture on the Panama Canal to the Vancouver Branch of the Canadian Society of Civil Engineers at its meeting on January 7th.

C. E. CARTWRIGHT and C. M. ODELL addressed the Mining Section of the Canadian Society of Civil Engineers at its meeting in Montreal on the 8th instant. The former's paper was entitled, "The Outlook for Mining in British Columbia." Mr. Odell spoke on "Initial Proceedings in Opening Up a Coal Mine."

JOHN R. FREEMAN, consulting engineer of New York, is at present conducting an investigation into the condition of the Montreal water supply conduit, before and after its collapse, for a body of prominent citizens. According to a statement he will report upon the advisability of installing a high pressure water system independent of the present waterworks plant.

J. H. HOUGH, president of the Hughes Owens Company, Limited, of Montreal, has just returned home after an extended trip to Europe and the West Indies. Mr. Hough well deserved this vacation, his first in fifteen years, during which time he has built up his business from a one-room affair to the present large company, owning valuable buildings in Toronto and Montreal, with three other important branches.

C. R. MURDOCH, B.A.Sc., has discontinued his services as waterworks engineer for Edmonton, Alta. Since August last Mr. Murdoch has been designing a filtration plant for the city, and has recently completed his work. He also had charge of the repair of the waterworks intake, which is nearing completion. Through a change of policy the position of waterworks engineer is being discontinued, the department being placed directly under the control of the City Engineer.

T. C. FORD, B.S., Ch.E., A.M., formerly chief chemist for the American Asphaltum and Rubber Company, has joined Messrs. Pullar & Enzenroth, engineering chemists of Detroit, Mich., and the firm will be known in the future as the H. B. Pullar Company. Mr. Ford has been closely associated with Mr. Pullar for the past five years, Mr. Pullar having been assistant general manager of the American Asphaltum and Rubber Company until about a year ago. Mr. Ford is not only familiar with the testing of bituminous materials, but has had wide experience in the actual building of roads and pavements. He was one of the first four engineers to complete the special post-graduate course of highway engineering at Columbia University.

REGINALD W. BROCK, Director of the Geological Survey of Canada, has been appointed Deputy Minister of Mines, to succeed DR. A. P. LOW, resigned. Professor Brock has been director of the Survey for the past twelve years, during which time his ability has been well recognized by the geological and mining authorities of the Dominion and abroad. He was previously a professor at the School of Mines, Kingston. He received his technical education at Ottawa Collegiate Institute, Queen's University, the University of Toronto, and Heidelburg. He was born in Perth forty years ago.

TORONTO BRANCH—CANADIAN SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Toronto Branch of the Canadian Society of Civil Engineers will be held on Wednesday, January 21st, 1914, at 8 o'clock p.m., in the lecture room at the Engineers' Club, 94 King Street W. Election of officers for the coming year and the presentation of annual reports will be included in the proceedings of the meeting.

COMING MEETINGS.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Annual Convention to be held in New York City, January 16th, 1914. Secretary, J. R. Wemlinger, 13 Park Row, New York City.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual meeting will be held in Montreal, Que., January 27-29, 1914. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal, Que.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th, 1914. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—Annual Meeting to be held in New York, January 21st to 23rd, 1914. Secretary, E. A. Scott, 29 W. 39th Street, New York City.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

CANADIAN SOCIETY OF CIVIL ENGINEERS

TWENTY-EIGHTH ANNUAL MEETING TO BE HELD AT MONTREAL NEXT TUESDAY, WEDNESDAY AND THURSDAY — M. J. BUTLER IS PRESIDENTIAL NOMINEE—REPORTS OF COMMITTEES—VISIT TO ST. LAWRENCE BRIDGE WORKS

FOR the first time in their new building on Mansfield Street, Montreal, The Canadian Society of Civil Engineers will hold their annual meeting next Tuesday, Wednesday and Thursday. Only a reception was held in the building—which was then only partially completed — during last year's annual meeting. Nineteen - fourteen, therefore, marks the beginning of a new era in the affairs of the Society, the members now formally inaugurating into their service the splendid new building of which the Society can properly be proud. The Engineers' Club of Montreal, at which there will be considerable entertainment for visiting members of the Society, have also greatly enlarged and handsomely remodelled their building during the past year, so the meetings this year will have the advantage of much greater facilities, both for work and pleasure, than have existed at any previous annual meeting.

Phelps Johnson

President of the Canadian Society of Civil Engineers in 1913; president of St. Lawrence and Dominion Bridge Co's.

M. J. Butler

President-elect of the Canadian Society of Civil Engineers for 1914; head of Armstrong, Whitworth of Canada, Ltd.

There will be five business meetings—at 10 a.m. and 3 p.m. Tuesday, at 3 p.m. Wednesday, and at 10 a.m. and 2.30 p.m. Thursday. The retiring president's address will be delivered Tuesday afternoon.

All visiting members will be guests of the Montreal members at a luncheon in the Windsor Hotel at 1 p.m. Tuesday. A complimentary smoking concert will be held at 8 p.m. Tuesday in the Society's building. The annual dinner will be served in The Engineers' Club at 8 p.m. Wednesday.

It is thought that there will most probably be a trip through the Mount Royal Tunnel, but the only excursion officially noted on the programme is to the works of the St. Lawrence Bridge Company, Limited, at Rockfield, near Montreal. The party will leave the Windsor Hotel at 10 o'clock sharp, Wednesday morning. By courtesy of the Montreal Tramways Company, special street cars will be provided to carry the party to and from the works. After the inspection of the works, the Bridge Company will entertain the visiting members at luncheon.

The president of the Bridge Company is the retiring president of the Society, Mr. Phelps Johnson. Mr. Johnson was born in the United States and practised as an engineer for bridge companies for some years before coming to Canada. From 1872 to 1879 he was engineer for the Hawkins Iron Works, at Springfield, Mass. In 1879 he became assistant engineer of the Wrought Iron Bridge Company, of Canton, Ohio.

In 1882 Mr. Johnson went to Toronto as engineer and manager of the Toronto Bridge Company, which afterwards became the Dominion Bridge Company. In 1888 he became chief engineer of the Dominion Bridge Company, at Lachine, P.Q., which position he retained until 1892, when he was appointed general manager of the company. He was elected president of the company at the last annual meeting, succeeding Mr. James Ross, deceased. Mr. Johnson had previously acted as

vice-president of the company. He is a member of the St. James Club, the Engineers' Club and the Royal St. Lawrence Yacht Club of Montreal. Mr. Johnson was vice-president of the Society in 1907 and was also a councillor for two terms of three years each. What is probably Mr. Johnson's most notable work was in connection with the design of the new Quebec Bridge, which will be an enduring monument to his ability as an engineer.

His successor as President of the Society will be Mr. M. J. Butler, of Montreal. Mr. Butler, like Mr. Johnson, will be elected by acclamation, as he was the sole choice of the nominating committee. Mr. Butler is well known as the former general manager of the Dominion Steel Corporation. Prior to that he was chairman of the board of management of the Canadian Government railways, and previously deputy-minister and

Prof. C. H. McLeod, Ma.E.
Secretary of the Canadian Society of Civil Engineers since 1891

chief engineer of the Department of Railways and Canals of the Federal Government. He is a member of several engineering societies and of a number of clubs, and has been engaged in some notable engineering projects in various parts of the Dominion. Mr. Butler is now the executive head of Armstrong, Whitworth of Canada, Limited. It was largely through the efforts of Mr. Butler and of Sir Percy Girouard, who is an honorary member of the Society, that there is now being erected at Longueuil, Que., a million-dollar Canadian branch of the well-known English steel-makers, Sir W. G. Armstrong, Whitworth Company, Limited. Mr. Butler was a vice-president of the Society in 1906 and 1907. He had previously been a councillor for two terms of two years each.

The nominees for vice-president are Mr. R. A. Ross, of Montreal, and Mr. A. F. Stewart, of Toronto. The retiring vice-president is Mr. J. G. Sullivan, of Winnipeg, who was a councillor in 1910 and a vice-president in 1911, 1912 and 1913. Mr. Sullivan is the well-known chief engineer of the Canadian Pacific Railway. Mr. H. H. Vaughan, of Montreal, and Mr. F. C. Gamble, of Victoria, will remain as vice-presidents during 1914, Mr. Vaughan having served two years and Mr. Gamble only one year of their three-year terms of office.

Mr. R. A. Ross was a councillor in 1903, 1906, 1907 and 1909. He is a consulting electrical engineer who has built up a national reputation, having been connected with a large amount of very important work.

Mr. A. F. Stewart was a councillor in 1911, 1912 and 1913. He is chief engineer of the Canadian Northern Ontario Railway and one of the chief men to whom credit is due for the success and rapid growth of the Mackenzie, Mann railway systems.

Either Mr. Ross or Mr. Stewart would, together with Messrs. Vaughan and Gamble, make a trio of excellent assistants to Mr. Butler in an effort to make 1914 a notable year in the history of the Society.

COMMITTEE REPORTS.

Among the committee reports which will be considered at the annual meeting, the report of the Committee on Reinforced Concrete is especially notable. The members of this committee are Mr. Walter J. Francis, chairman, and Messrs. S. Baulne, E. Brown, E. Brydone-Jack, J. Galbraith, P. Gillespie, H. M. MacKay, E. S. Mattice, C. N. Monsarrat, Michael Morssen, P. B. Motley and H. Rolph. They present a draft of standard general specifications for concrete and reinforced concrete as follows, certain subsequent modifications being noted at the end of the specifications:

MATERIALS.

1. CEMENT.

"Cement" shall be Portland cement complying in every particular with the "Specification for Portland Cement and Standard Methods of Testing" adopted by the Canadian Society of Civil Engineers.

As far as practicable the same brand shall be used throughout each piece of work.

2. SAND.

"Sand" shall be natural or artificial silicious material having particles graded from fine to coarse. It shall be free from dust, soft particles, vegetable loam or other foreign matter. The particles shall be of such a size that all will pass through a circular hole ⅛" in diameter in a thin plate and that none will pass through a circular hole 1-100" in diameter in a thin plate.

3. CRUSHED STONE.

"Crushed Stone" shall be silicious or calcareous material having fragments graded from fine to coarse. It shall be made by crushing natural rock or boulders having a crushing strength of at least 6,000 pounds per square inch, and be free from flat pieces, dust, soft particles and foreign matter. It shall be clean, hard and durable. The fragments shall be generally uniform in shape and of such a size as to pass through a circular hole 2½" in diameter in a thin plate and that none will pass through a circular hole ⅛" in diameter in a thin plate.

4. GRAVEL.

"Gravel" shall be the naturally produced material corresponding in every particular to the requirements of crushed stone.

5. CINDERS.

"Cinders" shall be hard, clean, vitreous clinker, thoroughly vitrified, crushed to such a size that all will pass through a circular hole 2½" in diameter in a thin plate and none will pass through a circular hole ⅛"

in diameter in a thin plate, and be free from sulphides, ashes, coal, coke or any material combustible at a temperature below 1,500° Fahrenheit.

6. WATER.

"Water" shall be fresh water and be free from oil, acid, alkalies or organic matter.

7. STEEL.

"Steel" shall have the properties set forth in Section 30, and be free from loose mill scale, excessive rust, oil or other foreign matter.

8. MORTAR.

"Mortar" shall be composed of cement, sand and water.

9. CONCRETE.

"Concrete" shall be composed of mortar and crushed stone or gravel, or of mortar and crushed stone and gravel.

10. CINDER CONCRETE.

"Cinder Concrete" shall be composed of mortar and cinders.

11. REINFORCED CONCRETE.

"Reinforced Concrete" shall be composed of concrete in which steel of small sectional area is systematically embedded at the time of depositing the concrete for the purpose of forming a composite structure in which the component parts act in unison in resisting applied forces.

12. REINFORCED CINDER CONCRETE.

"Reinforced Cinder Concrete" shall be composed of cinder concrete in which steel of small sectional area is systematically embedded at the time of depositing the cinder concrete for the purpose of forming a composite structure in which the component parts act in unison in resisting applied forces.

13. RUBBLE CONCRETE.

"Rubble Concrete" shall be the mass obtained by embedding boulders, fragments of rock, or both, in concrete while being deposited in place

METHODS OF CALCULATION

14. PROPORTIONING OF PARTS.

Every structure of concrete or of reinforced concrete shall be so designed that any possible combination of loading thereon will not produce stresses of greater intensity than the unit stresses given in this specification

15. LOADING GENERALLY.

The loads to be resisted shall be considered to consist of the dead load and the live load.

The dead load shall be the weight of the structure itself and any other fixed loads.

The live load shall be all loads other than dead loads.

The loads shall be reduced to their static equivalents by a recognized method of design. All dynamic, vibratory and impact effects shall be considered and provided for.

16. LOADS ON BUILDING COLUMNS.

In the case of columns in buildings which support three or more floors, reduction of live load may be made in accordance with this section, except in the case of buildings such as warehouses in which the floors are liable to be fully loaded simultaneously. For the columns supporting the roof and top floor the full live load shall be taken. For the succeeding columns taken in order, the full live load on such columns may be reduced successively by 5% until a reduction of 50% is reached. For all lower columns the live load shall be taken as at least 50% of that used in calculating the floors.

17. SPAN OF BEAMS AND SLABS.

The span of beams or slabs shall be the clear span plus the depth of beam or slab, but need not exceed the distance from centre to centre of supports. Brackets shall not be considered as affecting the clear span in this connection.

18. BENDING MOMENTS OF BEAMS AND SLABS.

Taking "w" to represent the equivalent static load per unit length of span of beam or slab, and "l" to represent the span length, the following bending moments shall be used,—

(1) For beams or slabs supported at both ends without constraint, $+\frac{wl}{8}$

(2) For beams or slabs continuous over three or more equal spans, $+\frac{wl^2}{12}$ at centres of interior spans and $-\frac{wl^2}{12}$ over their intermediate supports; and $+\frac{wl^2}{10}$ at the section of maximum bending moment in end spans and $-\frac{wl}{10}$ over their inner supports.

(3) For beams or slabs continuous over two equal spans only, $-\frac{wl}{8}$ over the centre support, and $+\frac{wl^2}{10}$ at the section of maximum bending moment in the spans.

When the spans are of unequal lengths, or when special cases of loading arise, the bending moments shall be computed on statical principles and due regard shall be paid to the influence of constraint at the supports in determining the maximum bending moments in the spans.

19. ASSUMPTIONS FOR STRESSES IN BEAMS AND SLABS.

The stresses in beams and slabs due to the bending moment shall be determined from the principles of the bending of homogeneous beams using the following assumptions,—

(a) that the modulus of elasticity of concrete in compression is constant,

(b) that the tensile resistance of concrete is negligible, and the steel reinforcement carries all the tension,

(c) that plane transverse sections of a beam before bending remain plane after bending,

(d) that the steel and concrete are properly bonded together, and that in beams reinforced on the compression side the two materials are stressed in compression in the ratio of their moduli of elasticity,

(e) that initial stress in the beam due to shrinkage of the concrete is negligible,

(f) that the depth of a beam is measured from the extreme compression layer to the centre line of the tension reinforcement.

20. PROPORTIONING OF TEE-BEAMS.

In beam and slab construction the design shall provide efficient bond between the slab and beam. The slab shall be regarded as forming part of the compression area of the beam. The effective width of slab so acting shall not exceed one-fourth of the span of the beam, and the overhang on either side of the stem of the beam shall not exceed four times the slab thickness, nor twice the width of stem of the beam.

Where a tee-beam is continuous, as at a column, and the bending moment undergoes reversal the stresses due to the end moment shall be computed as for a rectangular beam reinforced on both tension and compression sides. The compressive stress in the concrete may be 15% greater than the maximum specified in Section 27.

21. PROPORTIONING OF SLABS.

When the reinforcement of the slab runs in one direction only computations shall be made by the formulae for simple beams.

When employing slab systems where the reinforcement runs in two or more directions the designer shall use his judgment in the interpretation of theories regarding stresses therein, and of experimental results obtained from slabs so reinforced.

22. PROPORTIONING OF PIERS AND COLUMNS.

When the unsupported length of a compression member subjected to axial load does not exceed six times the least dimension of its effective area, it shall be deemed a pier, and if its unsupported length exceed the above limit it shall be deemed a column. All columns shall be reinforced.

The effective area of a column shall be the area included within the line circumscribing and touching the outermost reinforcing.

The diameter of a column shall be the least dimension of its effective area.

The length of a column shall be measured between its lateral supports, neglecting bracketing, and shall not exceed fifteen times its diameter.

UNIT STRESSES

23. ULTIMATE COMPRESSIVE STRENGTH OF CONCRETE.

In the absence of tests on concrete made from the materials to be used, the following values shall be taken as the ultimate compressive strength of concrete, twenty-eight days after mixing, having the proportions of ingredients as set forth.

[NOTE.—Reports to the annual meeting of other standing committees of the Canadian Society of Civil Engineers will be published in an early issue of *The Canadian Engineer*. EDITOR.]

Proportion of ingredients (cement, sand, crushed stone or gravel).......	Ultimate compressive strength in pounds per square inch				
	1:1:2	1:1½:3	1:2:4	1:2½:5	1:3:6
Kind of crushed stone or gravel............					
Granite, trap rock.......	3300	2800	2200	1800	1400
Gravel, hard limestone or hard sandstone.......	3000	2500	2000	1600	1300
Soft limestone or soft sandstone............	2200	1800	1500	1200	1000

24. Compressive Stress in Piers and Abutments.

The compressive stress in concrete piers and abutments shall not exceed 22.5% of the ultimate compressive strength of the concrete.

25. Bearing Stress on Piers and Abutments.

The bearing stress on piers and abutments shall not exceed one-third of the ultimate compressive strength of the concrete, if the compression be applied to a surface of concrete less than one-half the surface of the pier or abutment, otherwise the bearing stress shall not exceed 22.5% of the ultimate compressive strength of the concrete.

26. Compressive Stress in Columns.

The safe axial load on columns shall be determined by the following formulae,—

(1) Columns with longitudinal reinforcing only,

$$P = Af_c\,[1+(n-1)p]$$

(2) Hooped columns,

$$P = Af_c\,[1+(n-1)\,(2.4\,h+p)]$$

in which P = safe axial load, in pounds.

A = effective area of column, in square inches.

A_s = sectional area of longitudinal steel embedded in the concrete, in square inches.

$p = \frac{A_s}{A}$

f_c = 22.5% of the ultimate compressive strength of the concrete, in pounds per square inch.

n = modular ratio of steel to concrete = 15.

$h = \frac{\text{volume of circumferential reinforcing}}{\text{volume of column enclosed}}$

$\frac{P}{A}$ shall not exceed 45% of the ultimate compressive strength of the concrete.

For columns with longitudinal reinforcing only, p shall not be less than 0.01 nor more than 0.04.

Columns shall be deemed hooped columns when h is not less than 0.0075 nor more than 0.015, and when p is not less than 0.01. The value of (h+p) for hooped columns shall not exceed 0.05, and h shall not exceed p.

The length of a hooped column shall not exceed ten times its diameter as defined in Section 22.

27. Compressive Stress in Beams.

The compressive stress at the extreme layer of beams shall not exceed 30.0% of the ultimate compression strength of the concrete. The estimated compressive stress due to the end moment on a continuous beam may be allowed to exceed this value by 15%.

28. Shearing Stress in Beams.

The shearing stress, v, in the concrete of beams shall be computed by the following formula,—

$$v = \frac{V}{bjd}$$

in which V = total shear at any section, in pounds.

b = breadth of a rectangular beam, or of stem of tee-beam, in inches.

d = depth of beam, in inches.

jd = distance from tensile reinforcing to centre of compression, in inches.

For beams having tension reinforcing only, v shall not exceed 2% of the ultimate compressive strength of the concrete.

For beams in which part of the tension reinforcing is bent, as opportunity offers, so as to provide inclined shear reinforcing, the value of v shall not exceed 3% of the ultimate compressive strength of the concrete.

For beams in which v exceeds 3% of the ultimate compressive strength of the concrete additional shear reinforcing shall be provided in the form of stirrups inclined or normal to the tension reinforcing and looped around or connected to it. Using the above notation and letting s = spacing of stirrups, in inches, each stirrup shall be designed to withstand a pull of $\frac{2}{3}\,\frac{V_s}{jd}$ if set normally to the tension reinforcement, and a pull of seven-tenths of this amount if inclined at 45° to the tension reinforcing. The spacing of the stirrups shall not exceed the depth of the beam. Stirrups shall be of such a length that they approach within two inches of opposite faces of the beam, and they shall be so anchored or bonded that they can develop the pull for which they are designed. The value of v for beams so reinforced shall not exceed 6% of the ultimate compressive strength of the concrete.

29. Bond Stress.

The bond stress between concrete and steel shall not exceed 4% of the ultimate compressive strength of the concrete for plain or deformed bars, nor 2% of the ultimate compressive strength of the concrete for drawn wire.

30. Modular Ratio.

The ratio of the modulus of elasticity of steel to that of concrete shall be taken as 15.

31. Steel.

Steel for reinforcing shall have the following physical properties,—

	Medium Steel Bars		High Carbon Steel Bars		Cold-Twisted Bars from Medium Steel as specified
	Plain	Deformed	Plain	Deformed	
Ultimate Tensile Strength, in pounds per sq. inch = T.......	55,000 to 70,000	55,000 to 70,000	Minimum of 80,000	Minimum of 80,000	
Elastic Limit, Minimum, in pounds per sq. inch.	33,000	33,000	50,000	50,000	55,000
Elongation, Minimum, per cent. in 8 ins....	$\frac{1,400,000}{T}$	$\frac{1,250,000}{T}$	$\frac{1,200,000}{T}$	$\frac{1,000,000}{T}$	5%
Cold Bend Without Fracture (d = diameter, t = thickness)......					
For bars where d or t is less than ¾″	180° d=t	180° d=t	180° d=3t	180° d=4t	180° d=2t
For bars where d or t equals or is greater than ¾″	180° d=t	180° d=2t	90° d=3t	90° d=4t	180° d=3t

For each 1-8″ increase in diameter or thickness above ¾″ nominal diameter or thickness, and for each 1-16″ decrease in diameter or thickness for bars below 7-16″ nominal diameter or thickness a deduction of 1% shall be made from the above specified percentage of elongation; but these modifications for elongation shall not apply to cold twisted bars.

Material shall be free from injurious seams, flaws or cracks, and shall have a workmanlike finish.

Bars shall preferably be rolled from billets.

Cold twisted bars shall have at least one complete twist in a length equal to twelve times the thickness of the bar.

Re-rolled bars more than 1″ in diameter shall not be accepted.

32. Unit Stresses for Steel.

The following unit stresses for steel shall not be exceeded,—

In Tension,

Medium steel, 16,000 pounds per square inch

High carbon steel and cold-twisted bars, 20,000 pounds per square inch.

Re-rolled bars, 12,000 pounds per square inch.

In Compression,

All steel, 15 times the specified unit stress for the concrete in which it is embedded.

GENERAL REQUIREMENTS IN DESIGN

33. Limiting Proportions of Ingredients of Mortar Generally

Not more than three parts of sand shall be added to one part of cement

To make mortar, the exact proportions shall be determined before the commencement of the work, having in mind the strength and density required and the characteristics of the materials to be used.

34. Limiting Proportions of Ingredients of Concrete Generally.

To make concrete when using a mortar composed of one part of cement and one part of sand, not more than two parts of crushed stone or gravel shall be used; when using a mortar composed of one part of cement to one and one-half parts of sand, not more than three parts of crushed stone or gravel shall be used; when using a mortar composed of one part of cement to two parts of sand, not more than four parts of crushed stone or gravel shall be used; when using a mortar composed of one part of cement to two and one-half parts of sand not more than five parts of crushed stone or gravel shall be used; when using a mortar composed of one part of cement to three parts of sand, not more than six parts of crushed stone or gravel shall be used.

The exact proportions of the ingredients shall be determined before the commencement of the work, having in mind the strength and density required and the characteristics of the materials to be used.

35. Proportioning of Ingredients for Waterproof Concrete.

Where waterproofness is necessary the proportions of ingredients of the concrete shall be determined by experiment to obtain the requisite strength and the maximum density.

36. Limiting Proportions of Ingredients in Concrete for Beams etc.

In building construction one mixture shall be used throughout for girders, beams and slabs. In no case shall there be used a mortar containing more than two and one-half parts of sand to one part of cement, and to this mortar there shall be added not more than five parts of crushed stone or gravel.

37. Limiting Proportions of Ingredients in Concrete for Columns.

In building construction one mixture shall be used throughout for columns. In no case shall there be used a mortar containing more than two parts of sand to one part of cement, and to this mortar there shall be added not more than four parts of crushed stone or gravel.

38. Crushed Stone or Gravel for Fireproof Concrete.

Where fireproofness is necessary, crushed stone or gravel containing more than 5% of limestone shall not be used.

39. Fireproofing.

The steel reinforcing shall be protected by at least 3-4″ of concrete in floor slabs, by at least 1½″ of concrete in beams, and by at least 2″ of concrete in columns.

In concrete piers and abutments which may be subjected to the action of fire the outside concrete for a depth of 1½″ shall be considered as a protective covering and shall not be computed in determining the effective area of the pier or abutment.

40. Spacing of Steel.

The distance from centre to centre of adjacent bars shall not be less than the perimeter of the larger of the bars.

In slabs the distance from centre to centre of adjacent bars shall not exceed twice the depth of the slab.

41. Splicing of Steel.

As far as practicable all reinforcing bars shall be in one length. Welds shall be made, and the length of laps determined, so as to develop the full strength of the bar.

42. Minimum Lengths of Slab Reinforcing.

The ends of slab reinforcing shall completely cross the beam or girder on which the slab rests.

43. Reinforcing in Columns.

Vertical reinforcing bars shall be carried into the footings a sufficient distance to transmit the stress in the steel to the concrete of the footing by means of bearing and bond stresses. The bars of the lower sections of columns shall extend above the upper surface of the slab a sufficient distance to enable the bars of the next succeeding section of column to be effectively bonded with them.

Reinforcing bars over 1″ diameter may have their ends faced true and be butted with a sleeve not less than 12″ long.

The steel ties holding the vertical reinforcing in its assigned position shall not be more than 12″ apart.

44. Contraction Joints.

Contraction joints shall be provided unless sufficient steel is embedded to safely withstand temperature changes.

In mass concrete subjected to temperature changes construction joints shall be provided at abrupt changes of section, and preferably at sections not more than forty feet apart.

WORKMANSHIP

Mortar and Concrete

45. Foundations.

The foundations shall be trimmed as accurately as practicable and shall be at least as large as the dimensions on the approved drawings. Form work shall be erected wherever foreign material can become mixed with the concrete or mortar while the same is being deposited.

The bearing stratum shall be cleaned of all foreign material. It shall also be free from water if practicable. Under no circumstances shall mortar or concrete be deposited in running water.

46. Form Work.

Form work shall be substantially and accurately constructed. It shall be plumb and true to line, well fixed, braced and supported to carry the imposed loads, and be rigid enough to retain proper alignment and correct contours until the concrete will have become well set. Form work shall be sufficiently tight to prevent leakage. Immediately before depositing concrete the form shall be carefully cleaned out, after having been finally trued up. A coating of soft soap or oil may be applied to new forms. Such a coating shall be applied in every instance where form work is to be used more than once. Form work that has been previously used shall be thoroughly cleaned before re-erection and given a protecting coat of the same material as that already used on it. Form work shall be so fastened together that it may be removed without injury to any part of the permanent structure.

47. Storage of Cement.

Cement shall be stored in a weather-tight ventilated building. The floor of the building shall be raised above the ground to ensure dryness.

The cement shall be neatly piled in carload lots in the original sacks, and be marked in a distinctive manner for identification purposes.

48. Storage of Sand, Crushed Stone and Gravel.

All sand, crushed stone and gravel shall be piled on a site which has been cleaned free from vegetable and other foreign materials.

49. Measuring of Ingredients.

One sack of cement containing 87½ pounds net shall be taken as equivalent to one cubic foot of cement. All sand, crushed stone and gravel shall be measured by loose volume.

The necessary amount of water to produce the required consistency of mortar or concrete shall be determined from time to time taking into account the atmospheric conditions and the variations of moisture in the sand, crushed stone or gravel before mixing.

All of the materials shall be systematically measured throughout the whole of the work, and the required proportions shall be accurately maintained.

50. Mixing of Ingredients.

All mortar and concrete shall be made in batch mixers unless it is impracticable to do so, in which case it shall be mixed by hand.

Mixing by hand shall be done on a smooth water-tight platform. The sand and cement shall first be mixed dry until the whole mass is homogeneous and of perfectly even color throughout. Sufficient water

shall then be added to make flowing mortar. In the process of making the mortar the materials shall be turned over at least five times. If concrete is to be made the crushed stone or gravel shall then be added and the whole mass turned over at least four times and until it has become homogeneous and of even color and consistency.

Mixing by machine shall produce a homogeneous mass of concrete perfectly uniform in color and even in consistency, and the whole mass shall be in continuous motion within the machine for a period of not less than one minute.

The re-mixing or re-tempering of mortar or concrete which has partly set shall not be permitted.

The general consistency of the mortar or concrete shall be such that the mass will flow readily in the forms, and that it can be conveyed from the mixer to the forms without separation of the ingredients.

The temperature of the mixture on completion of the mixing shall not be less than 40° Fahrenheit. The crushed stone or gravel shall be heated artificially, if necessary, to obtain this result. In no case shall crystals of ice either in the sand or in the crushed stone be permitted to reach the mixing platform or the mixing machine.

51. Placing above Water.

The surface on which concrete is to be deposited shall be specially cleaned for the purpose. If the surface be rock it shall be given a coat of grout composed of equal parts of cement and sand well brushed into the surface and all the crevices. If the surface, vertical or otherwise, be of concrete which has set hard it shall be spalled or roughened and afterwards thoroughly brushed over with grout composed of equal parts of cement and sand. If the surface be of concrete which has not set hard the spalling or roughness may be omitted, but grout composed of equal parts of cement and sand shall be applied as specified above.

Mortar and concrete shall be placed immediately after being mixed.

Mortar or concrete which has partly set shall not be used.

Concrete shall be deposited in such a manner that the ingredients will not be separated, and the mass shall be consolidated by being worked after placing. The coarser ingredients shall be removed from contact with the formwork by the manipulation of a special tool.

The depositing of concrete at expansion joints shall be done with the same care and attention as that required to ensure a smooth finish to exposed surfaces.

In all cases laitance which may have formed on the surface of deposited concrete shall be carefully and entirely removed.

Concrete shall be deposited in approximately horizontal masses, and the work shall be stopped only at regular or temporary vertical bulkheads.

During freezing weather concrete shall be taken from the mixer and deposited in the forms so that no part of it shall be frozen and the temperature of the mass when deposited shall not be less than 35° Fahrenheit. The concrete shall be prevented from freezing until setting has taken place and until the process of hardening has begun.

Trowelled or floated horizontal surfaces shall be not less than one inch in thickness. They shall be composed of mortar or concrete proportioned according to the requirements for wear. The mortar shall contain at least one part of cement to two parts of sand. The concrete shall contain at least one part of cement to one part of sand and one part of finely crushed rock or gravel.

If possible the surfacing shall be applied immediately after the placing of the mass concrete, but when this is impracticable the mass concrete shall be thoroughly washed and treated with a coat of grout composed of equal parts of cement and sand thoroughly brushed in before the surfacing is applied. In trowelling or floating the surface pure cement shall not be used.

52. Curing.

Concrete shall be protected from the direct rays of the sun for at least three days after being deposited when the maximum temperature is above 60° Fahrenheit in the sun.

For a period of seven days after being deposited concrete shall be kept moistened when the maximum temperature in the shade is above 60° Fahrenheit.

53. Form Removal.

The forms shall not be removed from concrete work until the concrete is safely self-supporting, and, where additional concrete is to be added, until it has sufficient strength to safely sustain the superimposed load.

54. Placing Under Water.

When concrete is to be deposited under water the site shall be cleaned from all foreign matter and all currents of water shall be eliminated. The concrete shall be deposited immediately after mixing in such a way as to displace the water and at the same time to obviate the separation of the ingredients. The work shall be carried on in such a manner as to prevent the formation of laitance between successive masses of concrete.

Reinforced Concrete

55. General.

All the requirements of the preceding sections shall apply to reinforced concrete as far as consistent.

56. Crushed Stone and Gravel.

The largest fragments of crushed stone or pieces of gravel for reinforced concrete shall be of such a size as to pass through a circular hole ¾" in diameter in a thin plate.

57. Storage of Steel.

Steel shall be stored on skids clear of the ground and protected from rain and snow.

58. Fabrication and Placing of Steel Reinforcing.

All steel reinforcing shall be fabricated and placed in strict conformity with the dimensions on the approved drawings, and it shall be truly lined up and so held in position that displacement shall not occur during the depositing or manipulation of the concrete. All bars shall be free from bonds not specifically required by the approved drawings.

No material shall be permitted to adhere to the surface of the steel reinforcing until the concrete in which it is to be embedded is being deposited.

59. Cleaning of Form Work.

Immediately before depositing the concrete the form work shall be entirely cleaned of all foreign material, preferably by the use of a pressure hose and nozzle discharging water, steam or air.

In column forms an opening shall be provided at the bottom of the form work of every column in order that every particle of foreign material may be readily removed.

60. Depositing of Concrete.

The concrete shall be deposited in small quantities preferably as a uniform stream. It shall be manipulated in such a manner as to ensure perfect adhesion to the entire surface of the steel reinforcing and to remove all impounded water or air.

In depositing concrete in columns the work shall be discontinued at the elevation of the bottom of beams for a period of not less than three hours before depositing the beam concrete. In the absence of beams the elevation of the bottom of the slab shall be taken as the stopping plane. Before commencing the depositing of the beam concrete (or slab concrete in beamless systems), every column shall be examined for laitance, which if present shall be immediately removed.

The concrete for slabs shall be deposited continuously with the beams. Special care shall be exercised to procure perfect homogeneity of tee-beam construction.

61. Discontinuance of Work.

Every structural element shall be completed without discontinuance if practicable. Unless completed in one operation, beams and slabs shall be discontinued only by the use of vertical bulkheads placed at the section of maximum bending moment.

62. Freezing Weather.

In protecting reinforced concrete from frost a system which will drive the moisture out of the concrete shall not be used.

63. Form Removal.

The forms shall not be removed until the times named in the following table have elapsed after depositing concrete, not counting periods in which the temperature has been below 35° Fahrenheit.

Part	Minimum number of 24-hour days elapsed after depositing
Posts under beams and girders......	20
Floor slab panels..........	10
Wall forms...........	2
Column forms..............	4
Sides of beams and girders.........	4
All other parts................	10

Cinder Concrete

64. General.

All the requirements of the preceding sections shall apply to cinder concrete as far as consistent.

65. Storage of Cinders.

Cinders shall be stored on a site which has been cleaned free from vegetable and other foreign materials.

Reinforced Cinder Concrete

66. General.

All the requirements of the preceding sections shall apply to reinforced cinder concrete as far as consistent.

67. Size of Cinders.

The largest particles of cinders for reinforced cinder concrete shall pass through a circular hole ¾" in diameter in a thin plate, and none shall pass through a circular hole 1-8" in diameter in a thin plate.

Rubble Concrete

68. Soundness of Boulders and Rock.

All boulders and pieces of rock shall be perfectly sound, impervious and durable.

69. Embedding Rubble.

All boulders and pieces of rock shall be throughly cleaned of foreign material, and after being wetted they shall be either floated into the concrete matrix or placed upon a floating bed with full bearing, in which case the concrete, as it is being raised around them, shall be manipulated in a manner similar to that required for exposed faces of walls. The mortar in the concrete shall be made to adhere perfectly to every part of the surface of the boulders and rock.

TESTS AND INSPECTION

70. Tests of Materials.

All the materials shall be systematically tested in accordance with the recognized rules of the art for each material. The results of the tests shall comply with the requirements of these specifications.

71. Field Tests of Concrete.

Tests shall be made on concrete and mortar as the work progresses to check the density of the mixtures and the rate of setting. The test pieces shall be cubes, rectangular prisms or cylinders, having a volume of about one-fourth of a cubic foot. They shall be poured from the regular run of the mortar or concrete as deposited, and be left to set under the same conditions as the material in the structure. There shall be two such test pieces made from each day's work. The test pieces shall be carefully examined before the form work is removed.

72. Test Loads on Floors.

Test loads may be applied to a floor at any time after sixty days from the hardening of the concrete, but they shall not exceed one and one-half times the live load for which the floor has been designed. If no permanent deformations result from such loading the test shall be considered satisfactory.

73. Inspection.

There shall be constant competent inspection throughout the whole of the work

MODIFICATIONS AND CORRECTIONS BY COMMITTEE.

Section 7, first line, "Section 30" should read "Section 31."

Section 11, third line, Delete "composite."

Section 12, third line, Delete "composite."

Section 31, first line, Between "shall" and "have" add "preferably be made by the open hearth process and shall."

Section 31, second division, left hand column, Delete "Elastic Limit" and substitute "Yield Point."

Section 31, fourth division, Delete whole division and substitute the following:—

Cold Bend without Fracture, (t=thickness or diameter, d inside diameter of bend).					
For bars where t is less than ¾".	180° flat	180° flat	180° d=3t	180° d=4t	180° d=2t
For bars where t equals or is greater than ¾"	180° d=t	180° d=t	90° d=3t	90° d=4t	180° d=3t

Section 32, fourth line, Delete "20,000" and substitute "16,000."

Section 36, third line. Place period after "cement" and delete remainder of sentence.

Section 37, Delete first sentence and substitute "In building construction one mixture shall be used for the columns throughout the same story." Third line, Place period after "cement" and delete remainder of sentence.

Section 44, fifth line, Delete "forty" and substitute "thirty."

Section 46, seventh line, Between "A" and "coating" insert "thin, even."

Section 50, seventh and eighth lines. Delete "If concrete is to be made the" and substitute "If concrete is to be made, wetted."

Section 50, twelfth line, Delete "and" after "consistency."

Section 50, fourteenth line, Change period to comma after "minute" and add "and the entire batch shall be discharged before any further materials are placed in the machine."

Section 50, twenty-first line, Between "the" and "crushed" insert "water, sand and."

Section 50, twenty-second line, Delete "artificially."

Section 51, twelfth line, Between "be" and "deposited" insert "conveyed in water-tight carriers and be."

Section 51, after seventh paragraph insert two paragraphs as follows:—

"Arch rings shall be built in sections of such length as will permit of all concrete in any one section being placed without stopping. If circumstances render this impracticable, bulkheads shall be placed normal to the line of pressure.

"In building bench walls or abutments of arches, the tops of such walls shall be finished normal to the line of pressure, and no horizontal joints shall be made."

* * * *

REPORT OF THE COMMITTEE ON TRACK

Mr. C. H. McLeod,
Secretary, Canadian Society of Civil Engineers,
Montreal.

Dear Sir,—

Referring to your letter of May 15th, announcing the creation of a Committee on Track, composed of Messrs. F. P. Gutelius and A. C. MacKenzie and the writer, I beg to advise that, owing to a tremendous pressure of business, we were not able to hold a meeting until the 1st instant. This meeting was attended by Mr. MacKenzie and myself.

The subject assigned to the Committee is a very large and comprehensive one and the work to be carried on should be in accordance with a well defined programme, and, in order to conform to the wishes of the Council as to procedure, it seems to us that the Council should give a general outline of the subjects which should be first attacked.

This is the procedure generally followed in associations of this nature and is the one which we think will obtain the best results from the Committee.

The Committee is so small that we do not think we can carry on effective research work in a satisfactory manner, because in the work associated with track matters it is quite desirable that results obtained by the Committee should be after a very general study by the Committee, which should be representative not only as to individual railroads but locality. We are, therefore, impressed that there should be an increase in the membership of this Committee to at least eight or ten, and a Committee of this size can accomplish much more effective work.

We, therefore, recommend for consideration by the Council the following action:

1. That the Council shall instruct as to the general subjects it would desire given first attention, and we might suggest that two be selected from the following list:

Recommended specifications for tie plates.
Recommended specifications for angle bars.
Recommended specifications for various classes of tie treatment.
Recommended specifications for bolts, spikes, etc.
Recommended practice as to size of ties.
Recommended practice as to character of timber.
Recommended practice as to proper tie spacing.
Economics of Track Labor, embracing the following:

(a) Proper methods of conducting track work.
(b) Proper methods of measuring efficiency.
(c) Equating track values.
(d) Method of educating section foremen, and numerous other subjects could be suggested.

2. That the Committee membership be increased to ten.

We believe in the creation of this Committee the membership should not be entirely confined to railroad engineers, as there will be some features involved where it would be desirable to have the benefit of the views of men connected with steel manufacture, treatment of ties and other subjects which are associated with materials going into track use.

Respectfully submitted,

H. R. SAFFORD,
Chairman.

COMMITTEE

H. R. Safford, Chairman. A. C. MacKenzie.
F. P. Gutelius

MONTREAL, December 18th, 1913.

REPORT OF THE CANADIAN COMMITTEE OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION

The above Committee begs to report that during the first part of the year 1913 the Commission was very actively engaged in bringing to their final form the reports of the Special Committees on the Rating of Electrical Machinery, on Symbols, and on Nomenclature; in order that they might be presented at the then forthcoming Congress in Berlin, Germany.

This Congress was held as scheduled in the early part of September, and adopted to a large degree the above Reports, and also the recommendations of the National Laboratories of England, France, Germany, and the United States as to the characteristics of standard annealed copper. Through the courtesy of the Honourable W. B. Nantel, Minister of Inland Revenue, the Canadian Committee was able to send a representative in the person of the local Secretary, Mr. A. B. Lambe. A full report of the Meeting, which was attended by some seventy delegates, representing about twenty-four countries, will be issued shortly and will be obtainable on application to the Secretary of the Canadian Committee, but in the meantime, as evidence of the growing influence of the Commission, it might be mentioned that requests were received that the publications of the Commission be issued in German and Spanish as well as in English and French; further, that the Russian government, through the National Committee of that country, has extended an invitation for the 1917 Congress to be held in St. Petersburgh.

The General Secretary of the Commission, Mr. C. le Maistre, expects to pay Canada a visit early next year, on his way through to New York and San Francisco, in preparation for the next Congress, which is to be held in the latter city in 1915.

With the exception of Mr. J. J. Wright, of Toronto, who has resigned owing to business reasons, the membership and officers of the Canadian Committee remain as last year, namely—

L. A. Herdt, Chairman.	L. W. Gill.
O. Higman, Vice-Chairman.	J. Kynoch.
H. T. Barnes.	J. Murphy.
W. A. Duff.	T. R. Rosebrugh.

A. B. Lambe, Secretary-Treasurer.

L. A. HERDT,
Chairman.

OTTAWA, December 31st, 1913.

SEWAGE DISPOSAL COMMITTEE

820 New Birks Building,
4th June, 1913.

Prof. C. H. McLeod,
Secretary, Canadian Society Civil Engineers,
Mansfield Street, City.

Dear Sir,—

The Committee appointed by the Council, as set forth in your letter of the 14th of March last, to suggest names for the formation of a Committee on Sewage Disposal, and also to outline the duties of such a Committee, beg to report as follows:—

In view of the fact that a Committee on Sewage Disposal, of three years standing, has fully considered the subject and made a report thereon, which report was received at the last Annual Meeting of the Society, and also in view of the fact that since the date of your letter of instructions, a Committee has been appointed by the Council to represent the Society in co-operating with the Committee of the House of Commons in dealing with the same subject and in formulating legislation thereon, we are of the opinion that the appointment of any other committee is unnecessary until after the enactment of the proposed legislation.

Yours truly,
WILLIS CHIPMAN,
JOHN KENNEDY,
R. S. LEA.

SUPPLEMENTARY REPORT OF SEWAGE DISPOSAL COMMITTEE

On the invitation of Mr. George Bradbury, M.P., Chairman of the Committee of the House of Commons on the Pollution of Navigable Streams, Messrs. John Kennedy and R. S. Lea attended a Session of the Committee at the House of Commons, Ottawa, and gave evidence as to the problem in hand.

Professor C. H. McLeod, who was also present at the Committee meeting, testified as to the establishment of special courses in the universities on sanitation and allied problems.

R. S. LEA,
Chairman.

REPORT OF THE CONSERVATION COMMITTEE

In March last, the Chairman of the Committee on Conservation addressed a circular letter to the members of the Committee. Replies were received from a number of the members and are appended to this report.

Last year the Committee presented a report respecting Mr. Sauder's recommendation that the Society "urge strongly upon the Dominion Government the importance of making the necessary appropriations and providing the necessary staff to undertake in an intelligent manner the gauging of all streams of water supply and the location and survey of all sites suitable for reservoirs for the storage of water."

The Committee, in its report, enumerated briefly the requirements for adequate gauging of streams, the principal gauging operations that have been carried on in Canada, and its importance in connection with all water power developments. The collation and subsequent publication of all available data was strongly recommended.

On April 14 the Secretary wrote that Council were of the opinion that the Commission of Conservation should undertake the work of compiling and publishing the stream data above referred to. The pressure of other work did not, at the time, permit the staff of the Commission to undertake the work, but it is hoped that it will be commenced next spring and that all engineers will co-operate by supplying all available information.

The communication of Mr. R. O. Sweezey, Montreal, is as follows:—

"In so much as I am supposed to represent Northern Quebec on this Committee, I prefer to confine my suggestions for discussion to questions affecting that part of the country.

"WATER POWERS.—While I quite realize that the water powers of

Quebec are under Provincial control, I think that nevertheless the local government is open to receive recommendations from this body.

"Immediately north of the city of Quebec is an area of some 3,000 square miles set apart as a game reserve and known as the Laurentides National Park. This area lies between the waters of the Saguenay and St. Lawrence and comprises the headwaters of a number of important streams, including the Jacques-Cartier (drainage area 1,100 square miles), St. Anne de Beaupre (350 square miles), Batiscan and several others.

"In connection with the development of Seven Falls on the St. Anne River under a head of 430 feet, a minimum development of about 6,000 horse power is possible. The head waters of this river offer excellent opportunities for storage, which would increase the minimum available power to at least 12,000 horse power. But here the difficulty arises which seems diametrically opposed to ideas of conservation. The National Park authorities stubbornly resist any move to create storage within the Park, claiming damage to game by flooding areas and thus disturbing caribou, moose etc. It is hard to understand such arguments when it is a well known fact that the beavers, which are so plentiful in this park, do a great deal more damage by flooding than any possible engineering storage could do, yet no effort is made to remedy that evil. Moreover the important storage localities to be flooded are usually in deep valleys and burnt areas where the flooded areas are absolutely valueless. Considering that the city of Quebec is greatly retarded in its manufacturing growth by the lack of cheap power (steam power is now used for city lighting), and, further, in view of the fact that the tract of 3,000 square miles thus reserved is, apart from the timber rights, quite unproductive an area owing to its rough and mountainous nature, one of the least benefits that might be expected from it is the utilization of its natural value as a storage basin for augmenting its water powers.

"There seems to be a strong tendency, both in Dominion and Provincial forest park regulations, to forbid the establishing of artificial storage within park limits. I would like very much to hear any arguments which might be offered in defence of such a policy.

"Indians.—As a natural resource the Indians of Northern Quebec and Northern Ontario are important. They are fast dying off and no effort is being made to alleviate their sufferings or to provide means for their livelihood. In this connection I have recently written to the Rt. Hon. R. L. Borden. Copies of this correspondence are attached hereto.

"I should very much like to have a discussion of this subject by the members of this Committee."

Mr. W. H. Breithaupt, Berlin, Ont., has made a special study of flood conditions on the Grand River, Ont. He has promised a fuller report at a later date, but in the meantime has contributed the following:

WATER CONSERVATION

Control of the Grand River, Ontario

"In the way of preliminary investigation of the economic practicability of control of the flow of the Grand River, Ontario Peninsula, by means of storage, sufficient in volume to impound a large proportion of flood flow, and thus prevent excessive floods and give a well sustained flow in the low yield periods, the Hydro-Electric Power Commission has during the past month carried on, and is still continuing, a survey and various investigations throughout the river valley. A lineal survey from outlet to headwaters, establishing of bench marks with elevations and distances from outlet of the river, flow gaugings, and topographical delimitations of possible storage basins, have been the lines of work. Investigation of the basin in Pilkington township on the main river remains to be completed, and a satisfactory site for a sufficient reservoir on the Conestoga tributary, which empties into the main river a short distance below Pilkington township, remains to be found.

"The unfinished present stage of this work has prevented any conclusion being reached as yet. It is hoped that for a later report information that has long been wanted will be available.

"The various cities, towns and smaller communities in the drainage area of the river have made large growth during the past year. To many of them, flood diminution and sustained flow of the river are of vital importance. The spring flood this year was again very high, only slightly under the record flood of 1912, and did much damage along the entire course of the river.

"The rapidly growing manufacturing town of Galt on the river made an extended investigation during the past summer with a view to enabling passage of flood waters without local damage. The river channel is narrowed by encroaching buildings, and obstructed by piers of short span bridges and by small boulders and detritus on the bottom and along the sides. A plan for a smooth, well defined and unobstructed channel was prepared, but for various reasons no action has yet been taken."

Mr. A. E. Doucet, Quebec, writes as follows:

"I am sorry to say that I have not been able to devote very much time to look into possible suggestions for inclusion in the annual report of the Committee. As a railroad man, however, and familiar with the operation of railways through timber country, I am more than ever convinced that our generally accepted width of 100 feet for right of way is very much too limited. I know that this point has already been brought up before the Committee, but it seems to me that in future the right of way through bush lands should certainly not be less than 200 feet, and a law should be passed to this effect for all future construction work."

Mr. J. B. Challies, Ottawa, has contributed a very interesting memorandum respecting the proposed forest reserve in the basin of the Winnipeg River. He says:—

"In response to your request this morning for my views regarding the work of the Conservation Committee of the Canadian Society of Civil Engineers, I would submit the following:

"Engineers both in the Government Service and in private practice have for many years been seriously handicapped in their endeavour to secure quick and authentic information respecting the results of surveys, investigations etc. of the different departments of the Dominion Government and of the several Provincial Governments, by the lack of some central office to which enquiries could be addressed. The situation in the United States has been partially met by the creation of an office for the distribution of public documents issued by the various departments of the United States Government, and a monthly catalogue issued by the Superintendent of Documents. A similar office would meet the situation here.

"The question of the adverse effect on stream flow of the denudation of forest cover is probably one of the most important matters occupying the attention of engineers interested in water power, irrigation, water supply, navigation, or any other activity depending on water. Not only must the question be considered from a remedial point of view but also with a view to preventing existing forest cover at the headwaters of important streams from being burnt or improvidently logged.

"The particular situation in which I am officially interested is that in connection with the water powers of the Winnipeg River. The headwaters of this river are in the province of Ontario, and include the Lake of the Woods district. Fortunately this district abounds in large lake areas suitable for storage purposes and the land areas are, so far as I am able to learn, fairly well covered with forest growth. Owing to the location of this forest cover in close proximity to the prairie country, it has already become a prey to the unscientific lumberman, and it is only a matter of time until the commercial timber will be removed. Unless the lumbering operations are properly supervised and restricted and reforestation provided for, the present facilities that this district offers for storage and conservation of run-off will be dissipated.

"I am not aware that there is at the present time any forest reserve in the vicinity of the Lake of the Woods district, and am convinced that it would be in the best interest if the whole area were placed in a forest reserve in order that all logging operations may be under strict supervision of trained foresters, and also that adequate reforestation may be arranged for. Recommendations from the Conservation Committee of the Canadian Society of Civil Engineers to the proper authorities that such a reserve be created in the interest of the maximum advantageous use of the water resources flowing through and from the Lake of the Woods would surely be a matter worthy of consideration.

"There has been considerable discussion by the Conservation Committee regarding co-ordination or co-relation of the different hydrographic survey organizations of the various departments of the Dominion Service, and also of the Provincial Services. While the matter of internal organization of the hydrographic survey propaganda in Canada might not be one for the attention of the Committee, I do think the Committee might very well consider the advisability of recommending some systematic method of making the results of the various hydrographic survey organizations available to the public quickly and uniformly. My own opinion is that this could best be done by having one representative from each

Department of the Dominion Government connected with the hydro-graphic [illegible] work (a member of the Society) placed on a sub-committee of the Conservation Committee, with a view to giving this question special consideration."

Mr. A. J. McPherson, Regina, suggested the following matters and has promised a report thereon at a later date:

1. The development of methods of treating the large resources in the way of lignite scattered throughout Saskatchewan to make it more serviceable for the use of the people of the Province.

2. The collection and provision for industrial and commercial purposes of the sources of water supply in sections of the Province where the local supplies are shown to be becoming inadequate.

3. The development of the highways of the Province and the direction of the forces making for this so as to produce the largest results for the efforts expended.

4. The reclamation of various areas throughout the Province by drainage.

Mr. McPherson also enclosed an interesting report by Mr. R. O. Wynne-Roberts which deserves wide circulation as a very practical measure of conservation.*

Mr. C. E. W. Dodwell, Halifax, refers to a number of important matters as follows:—

"There is one very important matter that no doubt has engaged the attention not only of our Committee of the C. S. C. E. but the Commission of Conservation, of which you are Assistant Chairman; also I am aware that the Federal Government has done and is doing something in the matter, though I regret to say I have no definite knowledge and no official reports or blue books describing the work done or progress made I refer to the question of forestation, of which the importance is hard to over-estimate.

"If our C. S. C. E. Committee is not already in possession of full information in regard to the notable work that has been accomplished in Germany in forestation, I would suggest that steps be taken immediately to secure such information, with a view to the perfecting of a Forestry Bureau in Canada on similar lines. No doubt you are aware that forestry in Germany is a source of considerable revenue.

"In view of the rate at which timber is being used and our forests depleted, we should have thoroughly efficient and energetic forestry bureaus at work in every Province of the Dominion.

"I know that the Forestry Bureau of the United States Government at Washington is doing good work in the dissemination of literature and information in regard to forestry, and some months ago I obtained from the Forestry Office in Boston a number of interesting pamphlets on the subject.

"One very interesting feature of the question is the influence of forestation upon the climate of our North West. The whole matter is one of such great importance and interest that I feel under no obligation to apologise for mentioning it, though perhaps I should do so for my ignorance of what has been and is being done by the Federal Government.

"There is another important matter, that, so far as I am aware, has not engaged the attention of the Government and which certainly ought to do so.

"I dare say you often use alcohol in your domestic economy, for the purpose of making coffee or heating a chafing dish etc., and that you send to the druggist and pay 25 cents for about a pint or less of so-called methylated spirits, which when burning is often so evil smelling as to be almost unusable.

"In the United States, and I believe in most other civilized countries, denatured alcohol can be bought for about 50 cents per gallon, and it is coming into very general use for domestic cooking and heating purposes, and also for the production of power. There is a concern in New York called, I think, the Alcohol Utilities Company, which makes all kinds of utensils for the use of alcohol in cooking and heating as well as lamps for lighting purposes. The lamps are, of course, of the incandescent mantle type, and they are made of all powers, ranging from about 10 to about 500 c.p., the higher power lamps being, as they claim, very much cheaper in operation than electric lamps. I went through the place about a year ago and was amazed at the variety, simplicity and usefulness of the many utensils seen. Denatured alcohol in the United States is in fact a tremendous boon to the people, and I was told that some four or five immense distilleries in the United States, which, a few years ago were turning out whisky, are now confining their operations exclusively to the production of denatured alcohol, showing that, besides being a tremendous boon to the people, it is a profitable industry and no doubt one capable of very considerable expansion. Such an industry would, I think, be fully as suitable to Canada as it is to the United States, and there is no question whatever that it would be as great a boon here as it is proving to be in the States.

"I have discussed this matter with one or two Members of Parliament, who were all very favourably impressed with it, and they agreed with me that it was a matter that might very properly and profitably be taken up by the Government. My first suggestion would be that in any tariff revision that may come before the Government in the near future, the duty should be removed, in whole or part, from denatured alcohol for domestic, industrial or power purposes, and that encouragement in some way be given to the home production of this valuable article.

"If the Committee deem this matter worth an investigation I shall be glad to do what I can in procuring available information, so that we may be able at an early date to make it the subject of a report that will command the attention and interest of the Government and the people.

"Another matter of minor importance to the above has occurred to me as capable of development. There are in the country to-day many thousands of tons of sawdust lying in huge heaps at and around saw mills and up to the present time almost absolutely useless. It seems to me that some use should be found for this material. For instance, it might be mixed with a small proportion of some adhesive combustible substance, such as coal tar, crude oil or the refuse from oil distilleries, and compressed into briquettes for fuel; possibly some process might be discovered by which it could be converted into paper, but at any rate it might be given some value."

Committee on Conservation

James White, Chairman	M. G. Henniger
G. A. Bayne	H. F. Laurence
W. H. Breithaupt	R. S. Lea
E. E. Brydone-Jack	R. W. Leonard
H. J. Cambie	A. J. McPherson
J. B. Challies	R. McColl
John Chalmers	W. McNab
C. R. Coutlee	C. H. Mitchell
J. S. Dennis	W. R. W. Parsons
C. E. W. Dodwell	E. T. P. Shewen
A. E. Doucet	R. O. Sweezey
J. B. Hegan	T. H. Tracy

*Note.—Mr. Wynne-Roberts' paper is entitled "The Utilization of the Coal Deposits of Saskatchewan." The report is published by the Government of Saskatchewan and copies of the same may be obtained by those interested on application to Mr. A. J. McPherson, Chairman, Highway Commission, Regina, Sask.

THE ST. LAWRENCE BRIDGE COMPANY'S SHOPS

DESCRIPTION OF THE PLANT BUILT AND EQUIPPED SPECIALLY FOR THE FABRICATION OF THE QUEBEC BRIDGE AND OF THE FIELD EQUIPMENT FOR ITS ERECTION

THE St. Lawrence Bridge Company, Limited, was incorporated August 5th, 1910, with an authorized capital stock of $3,000,000, one-half of which was subscribed for by the Dominion Bridge Company, of Montreal, and one-half by the Canadian Bridge Company, of Walkerville, Ont. Its directors are Messrs. Phelps Johnson, Chas. Cassils, G. H. Duggan, F. L. Wauklum, and J. F. Weber, of Montreal; and Messrs. F. C. McMath, Willard Pope, and B. S. Colburne, of Walkerville. The president is Mr. Phelps Johnson; vice-president, Mr. Chas. Cassils; secretary and treasurer, Mr. J. F. Weber; superintendent, Mr. W. P. Ladd.

The company was organized to tender for the fabrication and erection of the superstructure of the Quebec Bridge, and was awarded the contract in April, 1911. This contract, at a figure approximating $8,650,000, was awarded on the basis of designs submitted by the company, differing from those of the Board of Engineers which had been appointed by the Dominion Government in 1908 to draft designs for a new structure at substantially the same location as stood the partially erected structure which collapsed on August 27th, 1907.

Articles dealing in a comparative way with the accepted design have appeared in *The Canadian Engineer* and elsewhere, as have also descriptions of the design and construction of the substructure. The accepted design, being larger and heavier than that of the old structure, necessitated the construction of new piers and abutments throughout. These are now completed and the approach spans are also in place.

Before giving a description of the company's fabricating plant, the outstanding features of the design of the bridge will be briefly reviewed, to outline the immensity of the problem which devolved upon the company with the award of the contract.

The Quebec Bridge will cross the St. Lawrence River at Neilsonville, about 8 miles above Quebec. It will have a total length of 3,239 ft. between abutments, with clear height of 150 ft. above high tide, while the main posts will rise to a height of 343½ ft. above water. Besides two 515-ft. anchor arm spans 310 ft. deep, it will have a 1,800-ft. centre span consisting of two 580-ft. cantilever arms connected by suspended trusses 640 ft. long. The superstructure will have two lines of pin-connected trusses, in vertical planes 88 ft. apart. It will be made of carbon and nickel steel, with members of a maximum shop length of about 90 ft. and shop weight of 140 tons.

Realizing that the erection of the superstructure was the chief problem connected with it, and that the peculiar design of the bridge would evolve many unprecedented engineering features; and fully cognizant of the effect of the stresses introduced by erection in the old structure, the St. Lawrence Bridge Company decided to build and equip a shop specifically for the work. The great size and weight of many of the truss members, the accuracy of workmanship, and the rapidity of construction required, left little alternative. The result is the present plant, which has cost about $1,000,000 to build. It is situated between Montreal and Lachine, about one mile from the plant of the Dominion Bridge Company, and on the Grand Trunk and the Canadian Pacific Railway. The accompanying figures, some of which are taken from an article in June 7th, 1913, issue of *Engineering Record*, illustrate the shop in plan and elevation. To this article we are also indebted for much of the following information descriptive of the works.

The plant is equipped for the fabrication of 2,000 tons per month of heavy riveted members. It has machine tools for precise work in finishing bearing surfaces up to 10 ft. square and boring long pin-holes up to 4 ft. in diameter through compression members and eye-bars. All fabrication is done in a single long shop, with receiving and shipping storage yards at both ends, with a comprehensive system of surface tracks and traveling cranes. Electric drive is used throughout, individual motors driving most of the principal machine tools and groups of smaller tools.

General Design of Main Shop.—The main building is 660 ft. long, and 160 ft. wide, for 440 ft. of its length and 190 ft. wide for the remainder, with a lean-to to be described later on. It has a concrete roof carried on transverse trusses spaced 20 ft. apart. At the receiving end these trusses have bottom-chord runways for girder cranes and are themselves supported on the wall columns of the building and on a line of centre longitudinal trusses of 100-ft. span, thus eliminating all but three interior obstructing columns in a length of 400 ft. At the other end of the shop all of the roof trusses are supported directly on columns, which support also the crane runways, parallel to the axis of the building.

The columns rest on concrete piers, with footings proportioned for the maximum pressure on bedrock at a depth of about 4 ft. below the surface. The roof trusses have spans of 60, 75 and 80 ft. and are of heavy construction, with riveted connections at panel points and full-depth connections to the columns. The structural steel-work weighs about 2,000 tons and was fabricated by the Structural Steel Company and erected by the Dominion Bridge Company.

The exterior walls are of brick, with concrete foundations, with a stone water table about 8 ft. above the surface of the ground. The floor is of concrete, with timber sleepers for the track rails and provisions for anchoring or clamping movable equipment.

The shop has a great window surface area and is provided with arc and incandescent lighting. It is heated by exhaust steam in a fan blast system designed to maintain a temperature of 50 deg. with the mercury at 20 deg. below zero outside.

Construction was commenced in 1911, and the foundations were finished before the end of the year. The erection of the steel-work was commenced in 1912, and fabrication of steel for the bridge commenced in the spring of 1913.

The plant arrangement provides for the entrance of raw material at one end of the main shop and the performance of successive fabricating operations as it passes continuously through the shop parallel to the longitudinal axis, until the finished members are delivered at the op-

posite end. The equipment is arranged for the amount of the different classes of work in the order of the successive operations, so that the average proportion of different classes of work will keep the shop uniformly

Note:—Pu. = Punch; Pl. = Planer; La. = Lathe; Dr. = Drill; Gr. = Grinder; A. = Furnace; B. = Forge.

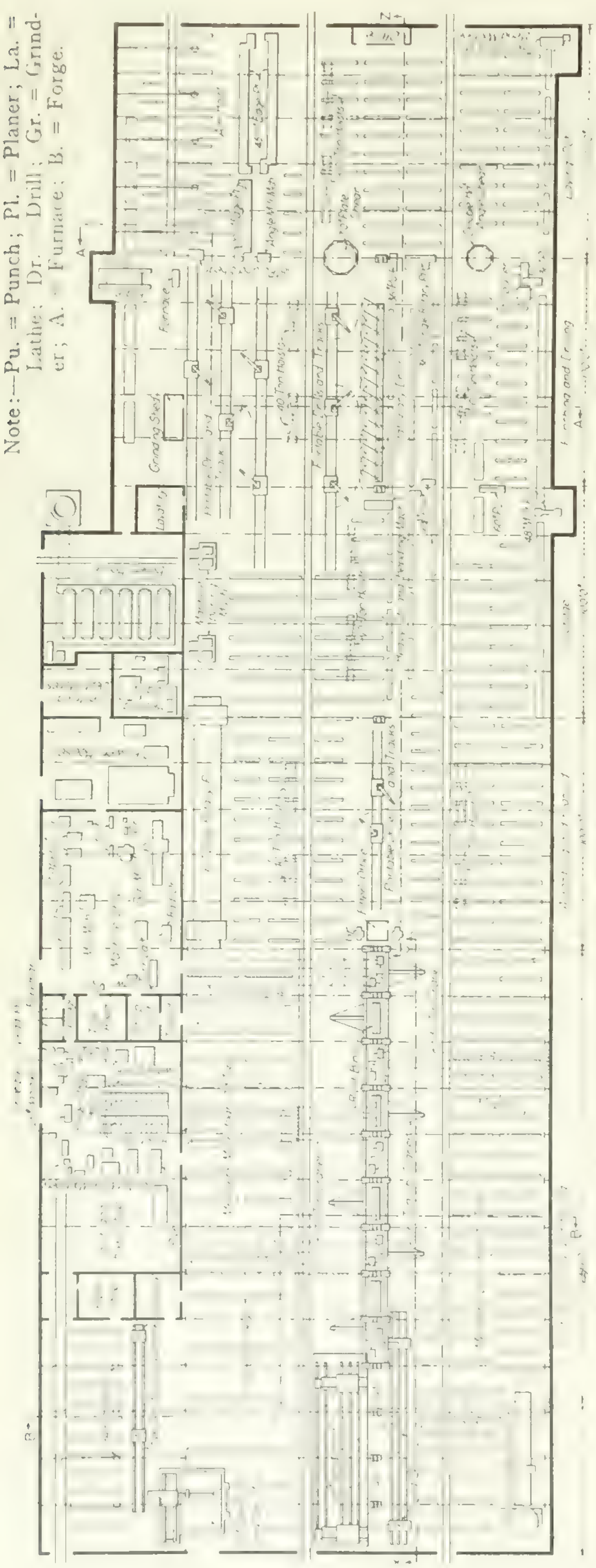

Fig. 1.—Floor Plan of Main Shop, Showing Position of Tracks, Columns, Trusses, and Machines.

busy with a constant progress of material and little lost motion or interference. Materials and supplies are received and products shipped on two tracks running through the plant parallel to the main building and commanded at both ends by cranes traversing the building. These serve the receiving storage yard at one end and the shipping storage yard at the other end of the shop.

Material is handled in the receiving yard by two 7½-ton trolley hoists on a 15-ton electric traveling crane, of 90-ft. span, with runways 500 ft. long, crossing three lines of narrow-gauge service tracks which enter the shop, two of them passing through to the other end and across the shipping yard.

Description by Panels.—The material entering the shop from the storage yard is placed on wooden skids with concrete foundations transverse to the shop axis, which occupy a large portion of the first 100-ft. panel. This panel is 160 ft. wide between main columns, besides a 30-ft. lean-to on one side, as shown in Fig. 2. It has a clear height of 21 ft. from the floor to the underside of the 80-ft. roof trusses, carried at one end of the centre-longitudinal truss. This construction is duplicated in the next panel. In the next two panels the width of the lean-to is increased to 60 ft., giving the entire shop a width of 220 ft.

In the first panel there is on one side a straightening machine with 80-ft. roller tables at each end and three large edge planers. They are served by two 10-ton assembling hoists traveling the full width of the panel on the bottom chords of alternate pairs of roof trusses. In the lean-to there is a 60-ft. roller table at one end of a set of rolls for straightening plates up to 120 in. wide, which are commanded by five 3-ton pneumatic trolley

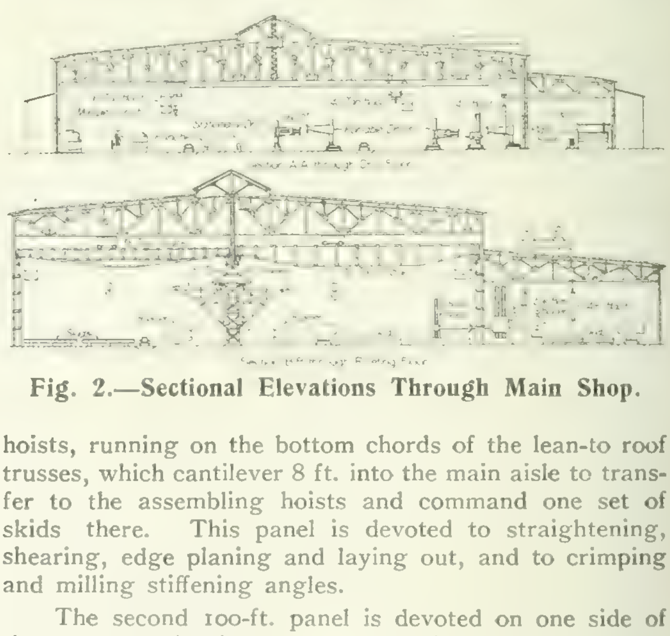

Fig. 2.—Sectional Elevations Through Main Shop.

hoists, running on the bottom chords of the lean-to roof trusses, which cantilever 8 ft. into the main aisle to transfer to the assembling hoists and command one set of skids there. This panel is devoted to straightening, shearing, edge planing and laying out, and to crimping and milling stiffening angles.

The second 100-ft. panel is devoted on one side of the centre longitudinal truss to punching and on the other side to drilling, and is served by two 40-ton and two 10-ton assembling hoists arranged, as are all of the others in this end of the building, like those in the first panel. The punching equipment is quite standard, and the machines, together with the shears, are arranged principally on the transverse lines at the ends of the panel so as to leave the interior space as much unobstructed as possible between main columns.

The special drilling plant includes 16 stationary heavy radial drills mounted on a long foundation, parallel to the shop axis under the centre truss, and 24 similar portable drills, each mounted on an individual truck, which travels on a portable track that can be clamped to the concrete floor. All of the drills have 6-ft. arms with vertical adjustments, have locking devices to the track,

and are driven by variable-speed motors. There are also 12 horizontal drills mounted on trucks to work in conjunction with the radial drills and for later use in drilling the field splices in the main members. It is the intention to assemble the members in temporary sections up to 40-ton weight and drill the rivet holes en masse.

In the third 100-ft. panel, as in the remainder of the shop, except the last 125 ft., the lean-to is separated from the main shop by a solid wall, reducing the width of the shop itself to 160 ft. In the third panel there are located two manhole boring machines to rough-cut pin-holes from 10 to 45 in. in diameter. The remainder of the space there is occupied by longitudinal and transverse skids for the storage of drills and punched materials, which are handled by two 10-ton assembling hoists.

On one side of the fourth 100-ft. panel there is installed a 60-in. duplex rotary planer with a bed 110 ft. long. Provision was also made for the installation as required of the portable drills forming the reeming plant, and the remainder of the space in this panel is devoted to assembling members up to 80 tons, which are handled by two 10-ton and two 40-ton assembling hoists.

Beyond the fourth panel there is a centre longitudinal row of columns, 20 ft. apart, dividing the shop into a 75-ft. and an 85-ft. aisle, and the height of the roof is increased to 38½ ft. from the floor to the under side of the roof trusses. Both of these aisles are 260 ft. long, and the width of the 85-ft. aisle is increased to 145 ft. for a distance of 100 ft. at the extremity by the inclusion of the lean-to space, the dividing wall being here removed and the addition thus provided being occupied by a duplex eye-bar boring machine with a bed 100 ft. long. The 85-ft. aisle is equipped with two 70-ton and one 35-ton cranes of 85-ft. span, traveling the full length of the aisle and serving to handle members weighing above 70 tons each, which will be fabricated here. At the end of this aisle there is a special horizontal boring machine for large shoes and main members, with a capacity for a 45-in. hole 11 ft. long. Each saddle has a vertical movement of 12½ ft., while the main column has a horizontal traverse of 23 ft., thus enabling it to bore several holes in the same piece at one setting.

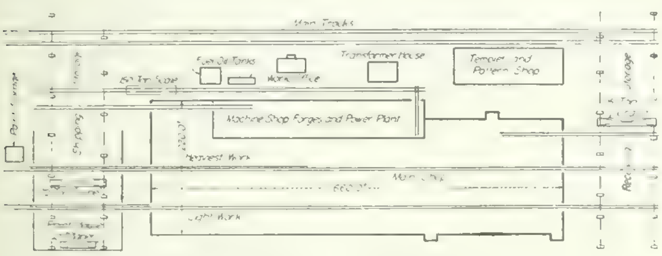

Fig. 3.—Arrangement of Buildings and Tracks.

Opposite the boring machine in the same aisle is a duplex vertical and horizontal planing machine for finishing the ends of large compression members for which rotary planing is not permissible. One of its heads is stationary, while the other has a power traverse on the 25 x 100-ft. bed, to enable it to be set for various lengths of members. The heads can make a 10-ft. cut in either a vertical or horizontal direction and are equipped with patent tool holders for cutting in the four directions, on both direct and return strokes. This machine will finish the 7 x 10-ft. bottom-chord pieces 42 ft. long, which weight 140 tons each.

The 75-ft. aisle is equipped with two 35-ton traveling cranes, one single-headed, 60-in. rotary planer with a 50-ft. bed and a duplex horizontal-chord boring machine with two movable heads on a bed 100 ft. long. This aisle is intended for the fabrication of members weighing less than 70 tons each.

Members in both the 75-ft. and 85-ft. aisles will be riveted by various pneumatic yoke machines with gaps of from 24 to 72 in., handled by 6-ton traveling jib cranes, with runways 180 ft. long on both sides of the centre row of columns. These cranes are 20 ft. high above the floor, with a clearance of about 18 ft. beyond the columns, and are special in that the bottoms are provided with vertical bearing wheels to carry the weight and with inclined reaction wheels in the planes of the braces to receive the thrust on special T-shaped tracks, inclined about 45 deg. to the vertical.

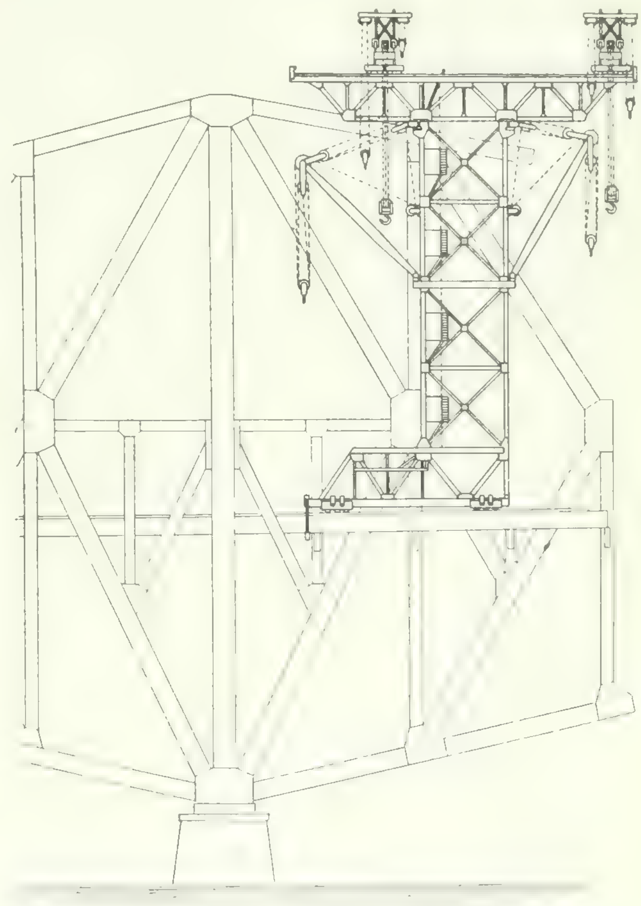

Fig. 4.—Side View of Erection Tower, on Cantilever.

The 60 x 340-ft. enclosed portion of the lean-to is occupied by the bolt and rivet shop, forge shop, the 60 x 80-ft. machine shop, generator and compressor room, boilers, coils, and fans for the heating plant, and by store-rooms, lavatory, offices, etc.

At the end of the shop there is a storage yard for finished members, which is commanded by a 70-ton crane of 80 ft. span, with runways 500 ft. long. One end of the runway is enclosed by a shed 140 ft. wide and 180 ft. long, open at one end, which provides shelter for painting and for a 120 x 120-in. x 30 ft. surface planer for finishing the larger shoes.

Opposite the laying-out panel of the shop is the 60 x 176-ft. two-story brick and steel template and pattern shop, equipped with power-driven wood-working tools and having benches nearly 100 ft. long. There is also a 30 x 50-ft. transformer house and a 25 x 45-ft. office building. The designing offices of the company are in Montreal.

Equipment at Bridge Site.—This reference to the equipment for the fabrication of the Quebec Bridge would not be complete without an outline of some of the methods which have been adopted for the placing of the various members after they arrive at the site. From foregoing descriptions of the design, it will be remembered that it was the intention to erect each of the cantilevers as an entirely separate structure, with its individual erection equipment. The centre span, weighing about 6,000 tons, will be completely assembled on barges at the river bank. When the time arrives for its erection, all navigation will be stopped at this point on the river. The span will then be floated into position, and will be hoisted by hydraulic power into its proper place, 150 ft. above the river.

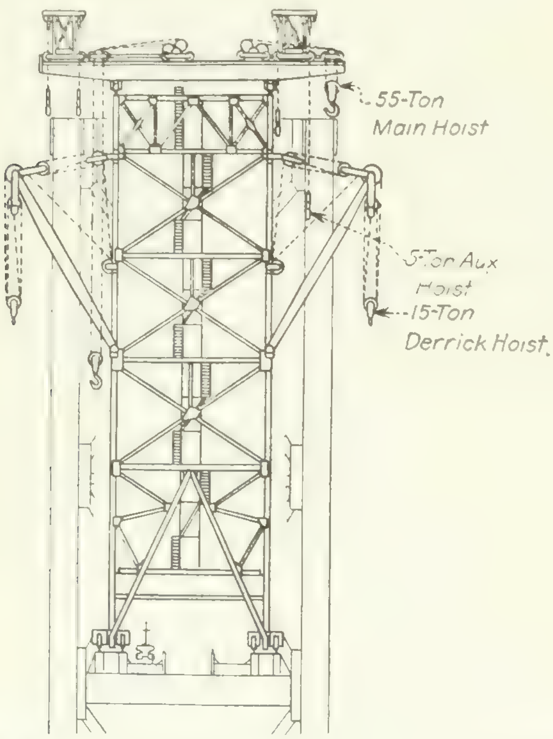

Fig. 5.—End Elevation of Erection Tower, Showing Location of Hoists.

As for this cantilever erection, the scheme and the design of the erection equipment are unparalleled in bridge engineering, and display the greatest ingenuity and exhaustive scientific investigation for the solution of the problem.

The erection of each cantilever of the bridge will be executed by means of a huge erection tower which will be carried by the cantilever itself, and moved outward along the bridge structure as its length extends from shore. These towers are of heavy steel construction with a height of 200 ft. from the carriage to the summit. Each travels by four trucks of six wheels each, spanning a double-track railway spur for the bringing in of bridge material. Each tower weighs approximately 840 tons. At this the weight is a minimum, careful experiment having been carried out to secure requisite strength without undue weight. The crane girders which project over the travellers are of nickel steel.

Each erection tower is equipped with a 90-ft. 15-ton derrick hoist on each of its four corners. Two traveling cranes, each of which carries two 55-ton main hoists and two auxiliary gantry cranes, operate at the top of the tower. Each of these gantry cranes is equipped with two 5-ton hoists, making eight 5-ton hoists for each tower.

With the exception of the travel of the four auxiliary gantry cranes all operations are electrically driven. The motor equipment of each tower is shown in Table I.

Table I.—Motor Equipment for Each Erection Tower.

Crane.	Service.	No. of motors.	Motor h.p.
15-ton derrick hoist	Hoist	4	50
	Swing	4	5
55-ton main traveler	Hoist	4	80
	Bridge	2	16
	Trolley	4	5
5-ton auxiliary gantry	Hoist	8	20
Total		26	752

This does not include, however, the motive drive of the main erection towers themselves along the cantilevers, this movement being accomplished by two of the 50-h.p. motors, which form the hoisting power for the 15-ton derrick hoists.

The electrical energy for these motors is brought to the site on each side of the river by high-tension transmission, where it is stepped down and converted by motor-generator sets to 250-volt d.c. Each sub-station receives its supply from separate systems and they are joined by submerged cables. Each is of sufficient capacity to supply the requirements of all the machinery as well as the air compressors which, in themselves, require in the neighborhood of 1,600 h.p. The object in converting from a.c. to d.c. is to afford better control and to permit the use of dynamic braking, which is necessary in the lowering of such enormous loads into position. The different speeds required during the placing of material are secured by resistances in series with the motor, which, during the period of retardation acts as a generator. The resistances are in the form of cast grids located at the base of the tower where their weight and size do not interfere with operations. Over 5,000 grids are required for this method of regulation.

The dynamic braking action is available for use only in retarding motion, while the motor armature is still rotating. When motion ceases the load is held stationary by magnetic brake. Safety devices on the important hoists prevent the load to over-travel when it nears its position.

Fig. 4 shows part of an uncompleted cantilever carrying one of these erection towers. Fig. 5 is an end view of the tower alone. These views are reproduced from the *Engineering Magazine* for December, 1913, containing an article by H. F. Stratton, descriptive of the erection equipment for the Quebec Bridge. The method of procedure, as described by Mr. Stratton is as follows:

It is planned to erect the north anchor arm over staging by what might be designated, purely for convenience, the first erection tower. When the north anchor arm has been erected, work will start on the south anchor arm by the use of the second erection tower. While the south anchor arm is being erected, the first erection tower will be at work on the north cantilever arm, and this will be finished substantially when the south anchor arm is completed. The first erection tower will then be taken down and reassembled at a point two miles below the bridge site, where it will be again set up for assembling the suspended centre span on barges. During the building of the suspended span, the second erection tower will be assembling the south cantilever arm, and these processes will be completed at substantially the same time. There then re-

mains merely the transportation of the centre span to the bridge site, and its subsequent elevation into place.

On each erection tower there will be built an operating platform at about the second-floor level, from which a clear view can be secured of the material as it comes in on flat cars and as it is later elevated by the cranes and finally properly placed in its permanent position. A house will be built in the centre of this platform for protecting the control apparatus from the weather, except that portion of it which is actually manipulated by the workmen, which will be out-doors on the platform. Six men will be stationed on the operating platform and two men on each of the main cranes at the top of the tower. To secure the proper co-operation by quick, effective communication between these widely separated workmen, a complete telephone system is to be installed with a central switchboard and permanent connections to the shore. An electrically operated passenger elevator will regularly serve the different floor levels.

The following is a brief description of the method of erecting any typical part of the structure. The member is brought in on flat cars underneath the erection tower, and by proper manipulation is elevated and located by two, or possibly four, of the 55-ton main hoists. The pin is then placed and suspended in position by means of one of the 5-ton auxiliary hoists, and a large ram for driving the pin is suspended from another 5-ton auxiliary hoist. The pins are equipped with hardened steel pilots which guide them through the links as they are being driven home to their places.

The date of completion of the bridge has been estimated to be either the year 1917 or 1918.

VALUE OF MELTING POINT TEST OF BITUMINOUS MATERIALS.*

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As in the case of a number of other tests for bituminous materials, the value of the melting point test has been much questioned, and there is considerable variation of opinion among engineers and chemists interested in the testing of bituminous materials as to the value of this test. Some believe that it is an important one in determining the quality and suitability of a bituminous material, some merely use it in conjunction with other tests as a means of identification, while still other authorities do not use the test in their work, and strongly recommend its total elimination from all bituminous work.

On account of bituminous materials being mixtures of hydrocarbons and not true solids, they have no true melting point, and some arbitrary method must be adopted. As nearly all bituminous materials must be heated before being used in actual work, the melting point was naturally one of the first tests to be thought of and many different arbitrary methods were used by chemists for running this test. One of the first of these methods and the one which the writer first used, was what is known as the "Capillary Tube" method. This method consists of using a capillary tube about six inches long, having an outside diameter of about 5 mm. and an inside diameter of about 3 mm. The capillary tube was drawn to a point and sealed at one end. A piece of the bituminous material to be tested was then rolled out until it was small enough to be inserted into the capillary tube. The tube with the material inserted was then placed in a bath of cotton-seed oil or sulphuric acid and the temperature raised at the rate of about 5° F. per minute. When small specks of melted material were noticed on the sides of the tube the first reading was taken and this was designated as "Starts to Melt." The next reading was then taken when the small specks of melted material began to run together and this was designated as "Starts to Run." The third and last reading was taken when the tube was entirely coated with the material and was uniform throughout. This was designated at "Melts All Over." This test was only used for a short time and was not found satisfactory as the results were variable and depended a great deal on a personal equation. The thickness of the tube and the method in which it was constructed also had considerable to do with the results obtained. This method has now been abandoned entirely by those interested in the testing of bituminous materials.

Another of the old melting point tests which was commonly used, was known as the "Mercury Test." The method for making this test is described by Mr. Clifford Richardson in his book "The Asphalt Pavement," as follows:—

"A crystallizing dish, about 2¼ inches in diameter and with 1½-inch sides, filled with clean mercury to a distance of ¼ inch from the top, is placed over a 20-mesh wire gauze and heated by a small flame protected from draughts by a chimney. On the surface of the mercury is placed a thin microscopic cover-glass, No. 2-0, carrying the specimen of asphalt under examination. When dealing with hard asphalts that can be ground rather coarsely, several fragments which will pass a 40-mesh sieve and be retained on a 50-mesh sieve (about .50 mm. diameter) are spread on the cover glass and placed upon the surface of the mercury, covered with a funnel, from which the stem has been cut and the thermometer passed through the orifice until the bulb is immersed in the mercury. It is held in position by a clamp attached to the ring-stand, holding the dish. Under the dish a burner is placed that can be regulated to a small flame and heat so that the rise of temperature will be from three to five degrees per minute. In a short time it will be noticed that the specimens will have changed from the brown or brownish-black color of the powder to that more nearly approaching the original, with a slight rounding of the individual grains. On further heating these globules flow together and form a thin sheet on the glass. The point at which the specimen begins to flow, as indicated by the thermometer, is noted as the melting or flowing point.

"Asphalts that cannot be ground are softened and pulled out to a thread and cut into small pieces, about 1 cubic mm. Several pieces should be placed on the glass together, as one will serve as a check on the other, and thereby lessen the chance of error. The softening point may be noted by the rounding of the particles and the beginning of the flow, or when the specimen begins to spread out, which is always at the point of contact with the cover-glass,

*Paper read before the convention of the American Association for the Advancement of Science at Atlanta, Ga., Dec. 31st, 1913.

is set down as the flowing point or the temperature at which the specimen will melt."

This test was a big improvement on the capillary tube method, but there were also many objections, and as in the case of the capillary tube test, the results were dependent to a great extent on a personal factor.

On account of the rapid development in the bituminous industry new and more scientific methods of testing were desired, and as the result of investigations and tests, two new methods for the taking of melting point have been developed. These methods are more scientific and different chemists in various parts of the country are able to obtain comparable results on the same sample or on the same class of bituminous materials. These two methods are known as the "Cube Method" and the "Ring and Ball Method." The "Cube Method" was recommended for use by a special bituminous committee of the American Society of Civil Engineers, and at the present time is probably used more than any other method. The determination of the melting point by the cube is as follows:—

> A ½-in. cube of the material is placed on the short arm of a No. 12 B. & S. gauge wire bent at right angle and placed in a 400 c.c. Jena glass beaker, tall form. The bottom of the cube to be placed 1 in. from the bottom of the beaker on which is a small piece of filter paper. The beaker is placed in a 600 c.c. common form beaker containing cottonseed oil. The temperature is raised at the rate of 5° C. per minute. When the cube just touches the bottom of the beaker the melting point is read from a thermometer placed within the bulb even with the cube.

The "Ring and Ball" method has been used by a number of chemists and is used more extensively in the testing of tars than asphalts. This determination is made as follows:—

> A brass cylinder ¼ in. high and ⅝ in. inside diameter is supported by wire in beakers as in cube method. The cylinder is filled with bitumen and a ⅜ in. bicycle ball placed on top. The temperature is raised at the rate of 5° C. per minute and when the ball falls to the bottom of the beaker the melting point is read from the thermometer.

There are a number of other methods in use by various chemists throughout the country and in different localities, one of the most popular of these being known as the "Thermometer Test," which consists of placing the sample of bituminous material around the bulb of the thermometer, inserting the thermometer in a test tube and emersing the test tube in an oil or acid bath. The bath is then heated at the rate of about 5° F. per minute, and the temperature at which the bituminous material drops from the thermometer, is taken as the melting point.

Another of the well-known tests is what is known as the "Kramer & Sarrow" method, but on account of its being little used, details will not be given.

As can be seen from the foregoing statements, there are a number of methods used for making melting points. Most of them have been developed during the last five years. On account of the many different methods which have been used and the fact that until very recently none of the methods were of sufficient scientific accuracy to make the results dependable, the value of the melting point test can well be questioned, and in the opinion of the writer, the results which have been obtained are absolutely of no value unless the details of the method used are given.

The results obtained by using the different methods of taking the melting point, are not comparable, and in a recent patent suit this was brought out very clearly; the results on the same sample varying considerably, depending upon the method used and the chemist making the test. On the same sample three different chemists varied more than 60° F. on a material having a melting point of 300° F. With this wide variation in results on the same sample, the melting point test is of little or no value.

In the writer's opinion, the melting point test, like other tests for bituminous materials, if properly used, is of considerable importance. The melting point test indicates in a large measure the lowest possible temperature at which a bituminous material must be heated before using; for instance, a blown oil product having a penetration of about 75 and having a melting point of 200° F., will require heating to at least 350° F. before using in a practical way, whereas an asphalt obtained by the direct distillation of oil having a penetration of 75 but a melting point of only 130° F. would require a heat of not more than 250° F. to 275° F. to be the proper temperature for use, and at a higher heat would likely be injured.

The melting point also is of considerable importance and value in identifying different bituminous materials or the different processes used in the production of these materials. This point is clearly brought out by Mr. Prevost Hubbard in his interpretation of the melting point test which is as follows: (Blanchard & Drowne's Text Book on Highway Engineering).

> "A determination of the melting point of solid bitumens is mainly of value as a means of identification and for control work on the part of manufacturers. The melting point of a bitumen is directly related to its hardness and brittleness, but the relations are not the same for all classes. Thus, at normal temperature, a blown oil with a melting point of 50 degrees Centigrade is neither hard nor brittle, while a tar pitch is both. As the melting point rises, however, they both become harder and more brittle. The climate under which a bitumen is to serve as a road binder, should be considered in connection with its melting point and this is particularly true of tar products."

In view of the fact that there are now two tests which are comparable and which are recognized as being capable of giving uniform results, the value of the melting point test from the present time should be of greater importance than ever before, and will enable intelligent comparisons of materials to be made.

In conclusion, the writer would state that in his opinion, the melting point test is of considerable value and should not be eliminated as one of the tests for bituminous materials, that when properly used, it is of importance in identifying different materials, that when properly used, it tends to give certain indications as to the quality of the bituminous materials under examination. It must, however, be understood that the results obtained at the present time with this test are not comparable with the results obtained even a few years ago, and that in all cases where the melting point is given, the method of testing should be indicated.

With these points in mind the melting point test is of importance and will be of greater importance in the testing of bituminous materials.

THE UNDERGROUND SURVEY WORK FOR THE MOUNT ROYAL TUNNEL

PRECISE ALIGNMENT AND LEVELLING METHODS THE ACCURACY OF WHICH WAS SO CLEARLY MANIFESTED AT THE MEETING OF THE HEADINGS ON DECEMBER 10TH, 1913—THE REWARD OF PERSEVERANCE IN THE ELIMINATION OF ERROR—INSTRUMENTS AND ACCESSORIES USED

By J. L. BUSFIELD, B.Sc., A.C.G.I., A.M. Can. Soc. C.E.

At 7 o'clock on the morning of December 10th, the culmination of the precise surveying and aligning of the Canadian Northern Mount Royal Tunnel was reached by the meeting of the bottom headings from opposite sides of the mountain, with an error of only ¾ in. in alignment and ¼ in. in grade. This exactitude is the result of over 1⅓ years' careful surveying, many calculations and much patience.

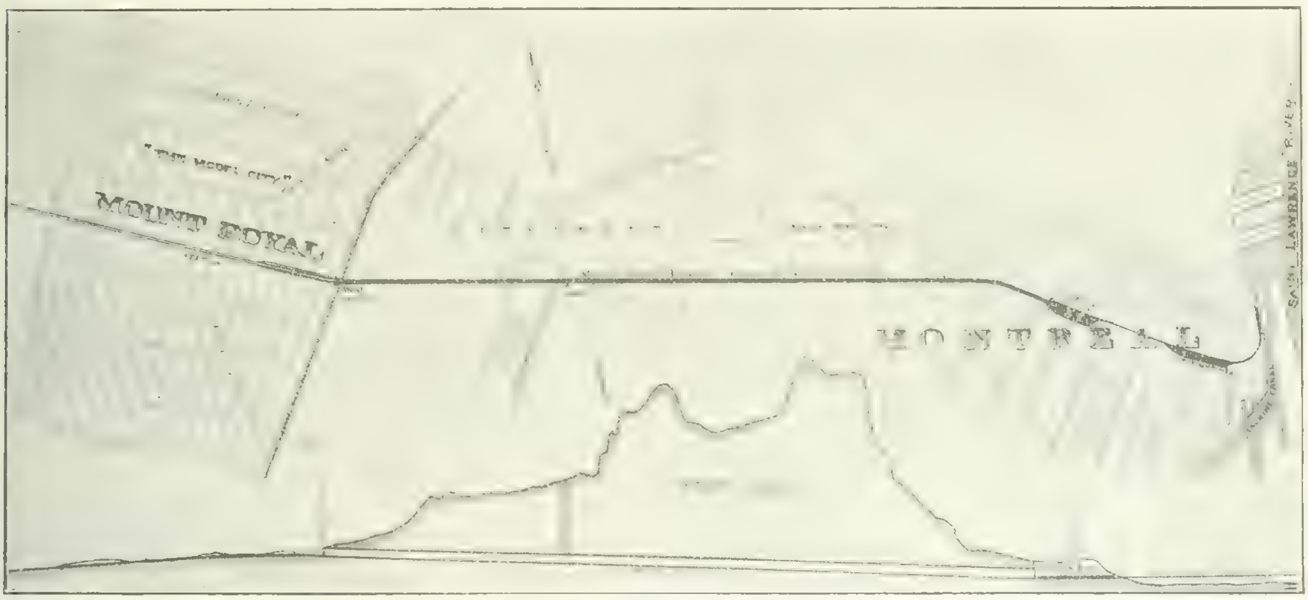


Fig. 1.—Plan and Profile of Tunnel Location.

In order to fully understand the nature of the alignment work performed it will be necessary to refer to Fig. 1, which shows the location in plan and profile of the tunnel. It will be seen that the tunnel is located on two tangents, connected by a 2-deg. curve in the neighborhood of Sherbrooke Street. The main tangent through the mountain is 2.8 mi. long. The method adopted for the construction of the tunnel was that of driving a bottom heading approximately 8 ft. high and 12 ft. wide. With the object of driving the headings from as many points as possible, one was driven towards the city from the West Portal; a shaft was sunk at Maplewood Ave. a depth of 250 ft. to the level of the tunnel, and headings were driven both ways from this shaft; and, at the city end a fourth was started westwards from the bottom of a 55-ft. shaft close to Dorchester and St. Monique Streets. The location of these shafts and the West Portal is shown in Fig. 1.

Previous to the actual commencement of the construction work, the relative location of the important points along the route of the tunnel was obtained by base line traverses around the mountain.* The long tangent was also very precisely located over the mountain, and permanent monuments established at all the transit points. (These were finally reduced to three in number between the West Portal and Sherbrooke St.) East of Sherbrooke Street the centre line of the tunnel was to be coincident with the centre line of McGill College Ave., but as the shaft at Dorchester St. was to be located to the north of this centre line, as shown in Fig. 2, it was found best to reference a line 33,678 ft. to the north of, and parallel to, the centre line of the Avenue, by means of points on the roofs of the most solid structures intersected by this line. It intersected the main tunnel tangent at a point on the roof of Strathcona Hall on Sherbrooke St., and the angle at this point was read a number of times with a 10-second transit until the final intersection angle of 21° 15′ 48″.6 was adopted. The location of this point was tied in to the co-ordinated survey lines. In this way its distance from the West Portal and from the location for the Dorchester Shaft was computed.

The actual work of driving the headings was commenced in July, 1912, when an opening was made under the C.P.R. tracks at the West Portal. In order to give

* For description of these base line traverses and of the precautions against inaccuracies [illegible], see *The Canadian Engineer* for February 27th, 191[illegible]

line for this heading, a concrete monument was built in the open cut west of the Portal at a point so located that it was possible for a transit to be sighted over the C.P.R. tracks on to the mountain to a foresight, and the depressed and sighted along the centre line of the heading (see Fig. 3). Shortly after this heading had been commenced, the Maplewood and Dorchester shafts were started. The former of these could not be located immediately over the tunnel centre line, so a parallel line 24 ft. to the south of it was established by carefully measured offsets, one on the side of the mountain above the shaft, the other on the flat roof of a convenient building between the shaft and West Portal. A transit tower (Fig. 4) was built adjacent to the shaft so that a transit could be set on the offset line by direct sights on to the two offset points, and could be also sighted on to the top of the shaft for setting the plumbing wires.

The alignment was transferred to the centre line of the heading and run both east and west from the shaft.

Monuments and Scales.—Before proceeding with a description of the methods used in laying out the lines described above, note should be made of a piece of apparatus used very frequently, and found almost invaluable in the alignment work. This was a brass scale fitted with a sliding vernier, as shown in Fig. 5. Whenever it was necessary to obtain the average of a number of points set by a transit, one of these scales would be used. Whenever required for this purpose they were rigidly attached to the roof timbers or to plugs set into the roof of the heading, as shown, with plumb-bobs suspended from the sliding verniers in front of "light boxes" or illuminated screens. These scales were only used as a means of obtaining averages and for temporarily holding the line. As soon as a good set of readings was obtained on any scale, the line was transferred to a permanent monument in the floor of the heading. These monuments were mostly of the type illustrated in Fig. 6, being made of a piece of gas pipe with a small piece of solid brass rod rivetted tightly into the top of the pipe. For giving the centre line at the working face, "spads," also illustrated in Fig. 6, were set in the roof every 50 or 60 ft.

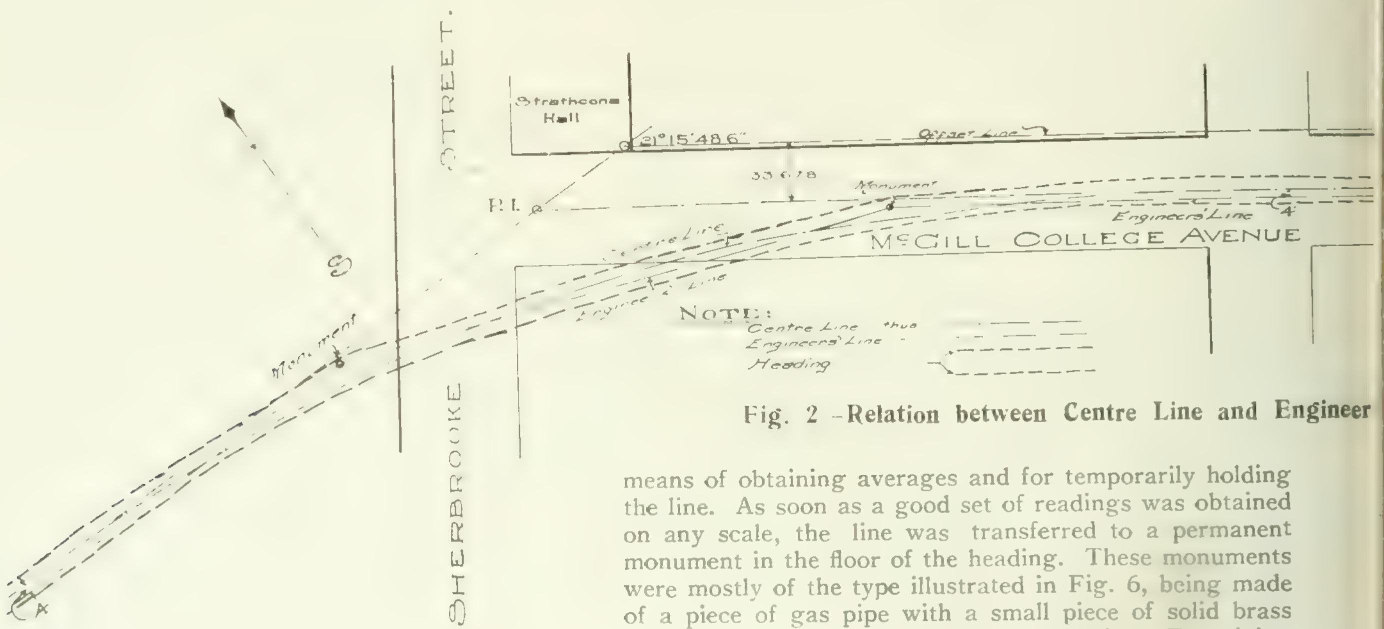


Fig. 2—Relation between Centre Line and Engineer

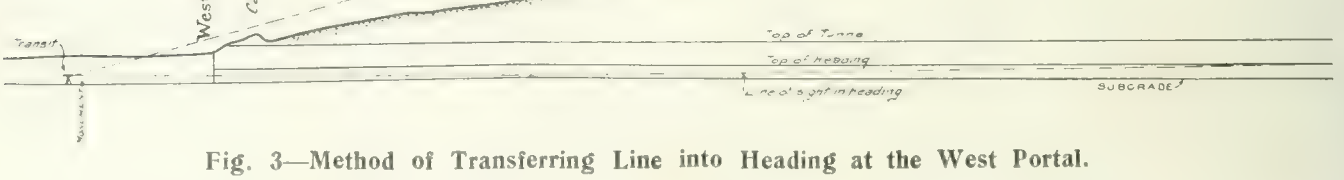
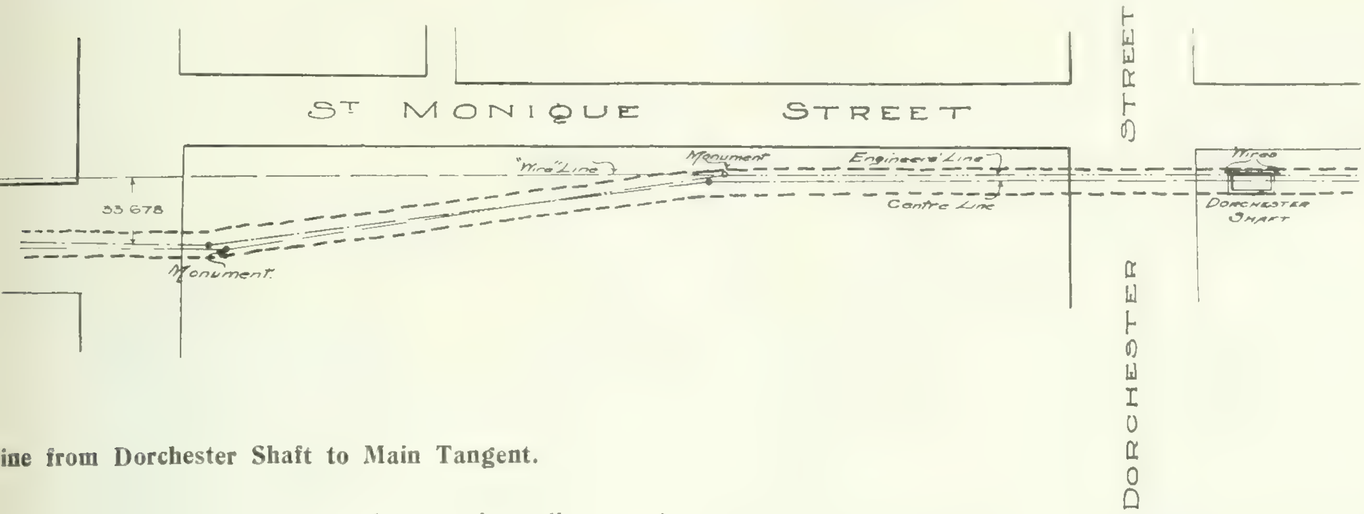


Fig. 3—Method of Transferring Line into Heading at the West Portal.

After the westerly heading had been driven 2,100 ft., a junction was made with the one from the West Portal, meeting with an error of less than 1-16 in. in alignment. After this junction had been made, the centre line was carried through from the West Portal to the working face in the heading, being driven east from the shaft. At the city end, as shown in Fig. 2, it was found advisable to run an engineer's line in the heading independent of the centre line. This enabled the alignment to be transferred up McGill College Ave. and around the 2-deg. curve onto the main tangent with a minimum of 4 angles. throughout the tunnel. They were also used for giving elevations and chainage.

Shaft Plumbing.—For transferring the survey lines down the shafts, No. 8 steel piano wires were used, being suspended as far apart as the limits of the shafts would permit. They were hung from reels attached to solid wooden frames, as shown in Fig. 7, and were passed over a notch in a tangent screw on the front of the frame by means of which they were finally adjusted to their exact position at their upper ends. The two wires were very carefully set on line at the surface by a transit, and

an instrument man was kept on watch throughout a series of observations. This precaution was fully justified, as frequently the wires would be jarred very slightly off line by a careless laborer or by some other cause. At the lower ends of the wires, 12-lb. and 30-lb. weights were attached at the Dorchester and Maplewood shafts, respectively. The weights were immersed in water and covered over, as shown in Fig. 8, in order to reduce the vibrations to a minimum. It was impossible to eliminate the oscillation entirely, and the centre of the swing of the wire always had to be estimated by the instrument man. In producing the line into the heading, the instrument man set the transit on line as close as he could estimate by eye, about 10 ft. from the nearest wire, and would then proceed to buck into line until, when he had sighted on the near wire (taking the centre of swing) and produced the line of sight on to the further wire, the latter would be bisected by the transit cross hair. It must be understood that in doing this when one wire was in focus the other was so much out of focus it was entirely invisible. At least 2 scales had been previously set up at each shaft, one being as far away as possible from the wires. When the instrument man had got the transit set on line he would proceed to set the plumb-bob at each scale on the line of his cross hair. When this was done the reading at each vernier would be recorded to the nearest 1,000th ft. This operation was repeated at each shaft a great many times. The observers at transits and scales were frequently changed, and the transit was reversed and set off line between readings. A lateral adjuster was frequently used to facilitate bucking into line. Care was always taken in placing the light boxes and plumb-bobs so that the minimum amount of movement of the telescope was necessary. At the Dorchester shaft it was possible to locate these in such a way that the telescope could be clamped to the verticle circle, and the only movement necessary was that of the focusing screw.



ine from Dorchester Shaft to Main Tangent.

Fig. 4.—Transit Tower at Maplewood Shaft.

At the foot of the Maplewood shaft it was only possible to locate the scales about 80 ft. apart (Fig. 9), and it was necessary to measure the 24-ft. offsets to the north at each scale on to monuments on the tunnel centre line. The precision of the 24-ft. distance was not so important as it was to have the two offsets absolutely identical. A variation of only one 100th ft. in one of these offsets would have meant an error of 3 in. at the meeting point 2,100 ft. away. This, added to a possible error from an inaccuracy in the wire line, might have made quite an appreciable error at the meeting point. A rigid wooden frame was made with needle points set 24 ft. apart and set up at each offset monument. The line was then transferred on to the monuments by means of a transit.

Turning Angles.—In the heading from the Dorchester shaft, 4 angles had to be turned off very precisely, as the exactitude of the main tangent depended largely on the accuracy of these angles. In setting off one of these angles a 10-sec. transit was first set up over the angle point, and in order to eliminate any errors due to inaccurate centering of the plumb-bob, etc., another transit was invariably used to set up the larger transit vertically over the angle point. The transitman would then turn off the angle roughly and have a small mark made on the foresight monument. The precise angle to this rough point would then be obtained by "wrapping up" the angle 5 times, thus giving a reading approximately to 2 seconds. The method of "wrapping up" is as follows: Clamp the plates at zero, sight on to the backsight; (2) unclamp the upper plate, sight on to foresight, and take the first reading of the angle; (3) leaving the upper plate still clamped at the first angle, unclamp the lower plate and turn back on to the backsight again; (4) unclamp the upper plate again and turn to foresight. Repeat the whole operation until 5 readings have been obtained. The last reading, divided by five, should be very close to the first reading and will be a value of the angle practically to 2 sec. if the work has been carefully performed.

After the precise angle to the rough point had been obtained in this manner, by taking the difference between this angle and the angle required, and also knowing the distance between the angle point and the foresight, it

was possible to calculate the amount the true point should be to right or to left of the preliminary mark made on the monument. After a new point had been obtained in this way, the angle was again wrapped up five times by different observers, and the whole operation repeated until there was no possibility of error of even 1 sec. in the angle.

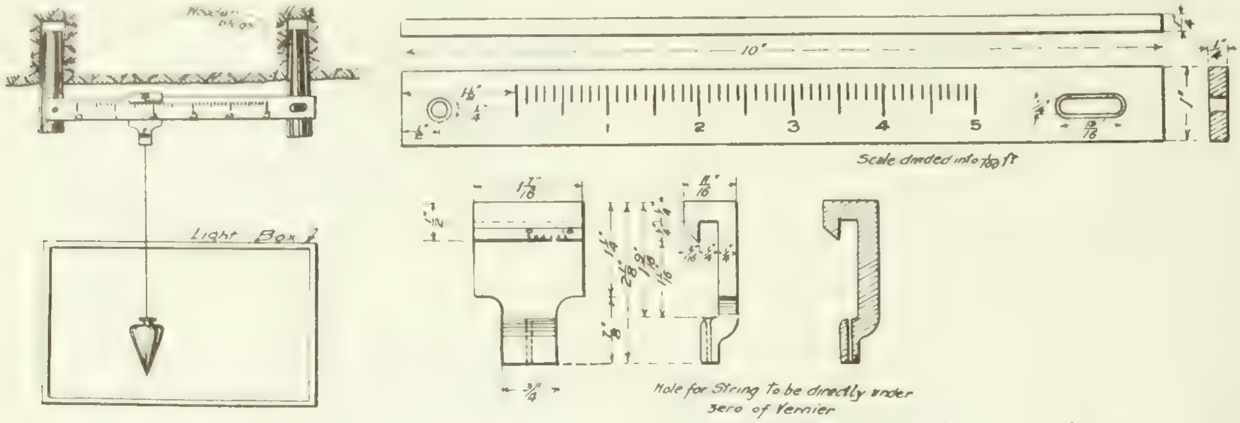


Fig. 5.—Detail of Brass Scale and Method of Fixing in Roof of Heading (on left).

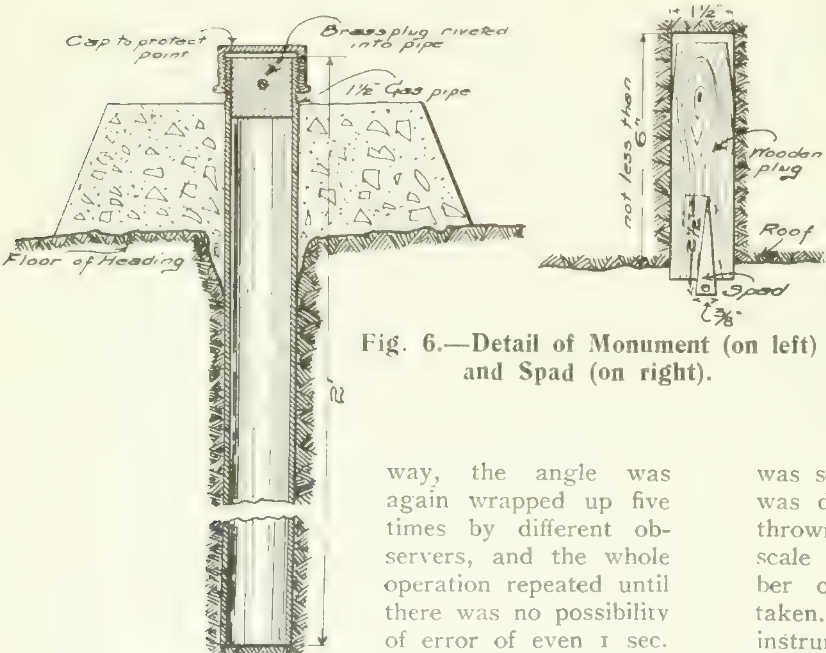


Fig. 6.—Detail of Monument (on left) and Spad (on right).

Producing Tangents.—After the last angle had been turned off to a point as far away as possible, the tangent had to be produced westwards. At the same time the tangent was being gradually prolonged eastwards from the West Portal. In producing a line from any 2 monuments a scale was set up at the foresight and the transit was set up adjacent to the intermediate monument. Instead of being set up over this monument by means of a plumb-bob, the method described in the article previously referred to was used. The transit was set up about 10 ft. away from the monument and bucked into line until the cross hair bisected both the backsight and the punch mark at the monument at which the transit was set up. After this was done the line was thrown ahead to the scale and a large number of readings were taken. By reversing the instrument between each set and having different transitmen take readings, instrumental and personal errors were reduced to the minimum.

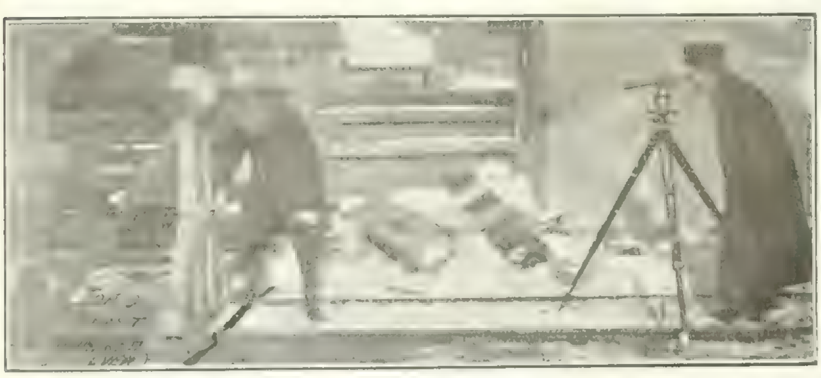


Fig. 7.—Setting Wire on Line at Surface.

Fig. 8.—Taking Line From Wires at Foot of Shaft.

Targets.—In producing the tangents it was naturally advisable to use as long sights as possible, and for sights of over 1,000 to 1,200 ft. the ordinary plumb-bob was not satisfactory. For taking these long sights 2 types of targets were used, from both of which good results were obtained on sights as long as ½ mile, in a smoky heading. The one shown in Fig. 10 was used at points where a fixed backsight was required. The other, shown in Fig. 11, was used at foresight stations where a movable target was required, being attached to a sliding vernier at a scale. The former was made by cutting square holes out of a

piece of sheet tin, with their diagonals located exactly on a straight line, and the tin attached to a piece of wood with similar, but larger, holes cut in it. This target was attached with horizontal and lateral adjustments to the front of a large, light box, containing sockets for about 15 lamps. In practice this box and target were set up so that the centre line was exactly over the punch mark on the monument, and was

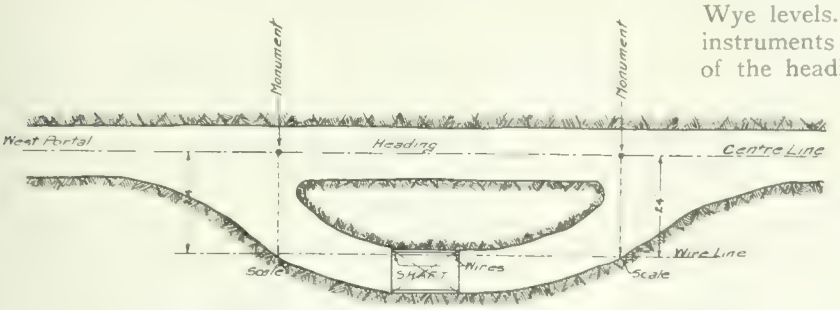


Fig. 9—Alignment at Bottom of Maplewood Shaft.

set vertical by means of a transit set up a short distance away. Once set up the target was clamped and the box kept steady by rocks or by nailing to convenient timbers.

The type of target shown on Fig. 11 was designed by A. F. Duguid, transit man of the party on the Western Division, as a substitute for the plumb-bob in places where a movable target was necessary. Canadian and United States patents have been applied for in connection with it. The one originally used was made from an 18-in. length of 2½-in. seamless steel pipe, by cutting in it pairs of slots 2 in. long and 180° apart at regular intervals. These slots were accurately cut to one 100th in., and the hole in the cap through which the suspending cord was passed was very accurately centered. The ends were weighted with lead in order to give the target stability. When suspended in front of a light box, this target presents a silhouette which encloses a series of bright areas, varying in width. If the vertical cross hair of the transit is made to bisect the bright areas, the line of sight will be in the same vertical plane as the point of suspension. It is immaterial from which direction the target is sighted, as there will always be a number of bright areas in view.

Levelling.—Although the work of levelling through the tunnel, and of keeping the floor of the headings to the correct grade, was not so difficult to carry out as the alignment work, it was even more essential that it should be carried out accurately. An error of 3 in. in line would not have been a very serious matter, but 3 in. difference in grade would have meant 3 in. to have been taken off one heading floor, or an additional amount of concrete or ballast to have been used on the other side. The permanent monuments already described were used for bench marks throughout the tunnel. In levelling between 2 monuments the level was set up equidistant between turning points about 100 ft. from the instrument. The difference in elevation of the turn points was taken by 3 independent operations of setting up, and a mean of all three readings taken. New York rods with sliding targets reading to one 1,000th ft. were used. All elevations were run separately by different observers, and differences of 100th ft., or more, were not accepted. For the working face elevations were taken on each spad. Their chainage being known, the height of the spad above sub-grade could be computed, and by sighting across footrules, or by any other method the foremen might prefer, a line could be marked across the working face a certain number of feet above sub-grade. All elevations were referred to the datum of the Montreal Harbor Commissioners.

Instruments, Etc.—For ordinary work, such as putting in spads and rough surveys, a 30-second transit with a 6¼-in. plate was used; but for all precise work, turning off tunnel angles, etc., a 10-second instrument with a 7-in. plate was used. The levels were all taken with 18-in. Wye levels. Considering the rough use to which these instruments were subjected, due to the dirt and drippings of the headings, it was remarkable how well they kept their adjustments. It should also be borne in mind that the great majority of the work was done under very adverse conditions of atmosphere and surroundings.

A great variety of light boxes was used, all of simple construction, being made from empty boxes, tin cans, and anything to which lamp sockets and reflectors could conveniently be attached.

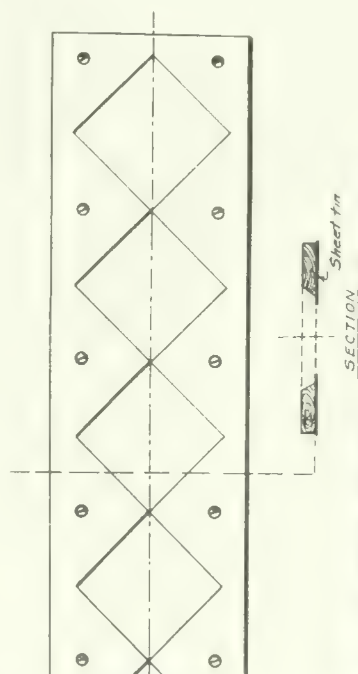


Fig. 10—Target for Fixed Back-sight.

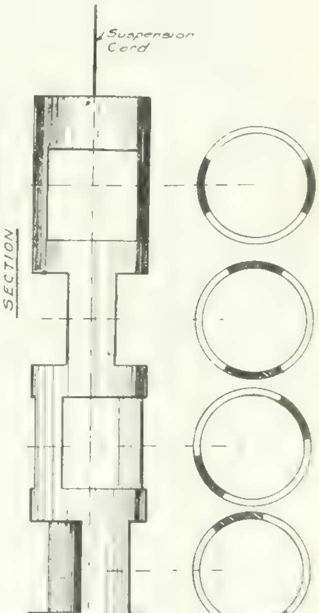


Fig. 11—Target for Movable Fore-sight.

Personnel.—The whole of the alignment work was carried out under the direction of Mr. Howell T. Fisher, M. Can. Soc. C.E., Tunnel Engineer; Mr. R. S. Basset, Asst. Engineer, was in charge of the alignment and survey work for the Western Division and the writer for the Eastern Division.

THE CONSTRUCTION OF CREOSOTED WOOD BLOCK PAVEMENTS.*

By R. S. Manley.

A CREOSOTED wood block pavement should show no evidences of wear for many years if the proper materials are used, and if they are assembled in the proper way. The correct depth of base, or foundation, varies with the soil conditions, but the materials forming this concrete foundation and the methods of mixing are in such common use as to be standard and easily secured.

We are interested principally in the construction placed on top of the concrete. The principal causes of defects of more or less serious nature are (1) irregular or uneven surface due (a) to careless laying, (b) to shifting of sand cushion, (c) breaking or settling of concrete. (2) Expansion difficulties due to the entrance of water into the blocks, either by way of the joints or from below.

The first (irregular or uneven surface) is death to any paving material, because a depression in the surface holds water, and repeated churnings of wagon wheels in the depression are bound to cause an enlargement and deepening of the depression.

To avoid (a) the concrete should be mixed quite wet and finished smoothly with a flat wooden spreader, which gives a surface practically as even and uniform as could be obtained by templet. On this should be spread from one-half to one inch of clean sand, making the sand cushion conform to the contour of the finished street. On this place the blocks quite closely together, roll thoroughly until a perfect surface with no inequalities has been obtained and until the blocks are firmly in place. It will require a great deal of rolling to accomplish this, but the end justifies the means. After this fill all joints two-thirds full of hot bituminous filler of such melting point as is suited to climatic conditions, and spread a thin coating of sand thereon. The use of the bituminous filler is, in my estimation, the most important of all. It converts the street into an effective watershed which, without absorbing any of the water, directs it into storm sewers or other drainage paths. Should any water remain on the surface the wind and the sun, both good evaporative agencies, will rapidly dissipate it.

Now you have an absolutely even surface, waterproofed and converted into a watershed. This surface cannot be worn by traffic, because the pressure of wheels is even and regular, and there is no dropping or jolting of wheels entering and leaving low spots. The blocks are laid tightly together, so that there is no wearing at the joints. There can be no change in the sand cushion as long as the surface remains intact, a solid sheet, in fact, of wood block cemented together by the filler, and consequently the difficulty of shifting cushion is avoided. It is assumed that the concrete is sufficiently strong so that it will not break or settle. In planning the depth, any error should be on the side of too great, rather than too little depth.

Expansion difficulties are eliminated by the use of bituminous filler, for there can be no expansion without absorption of water, and no absorption of water when all rainfall is conducted quickly to drainage sewers. In addition to this it must be remembered that with the bituminous filler each block is surrounded by an individual expansion joint.

The other way of constructing wood block surface which is sometimes recommended is to provide a mixed sand and cement cushion and sand-filled joints or interstices. The sand and cement cushion does not give the opportunity for absolutely smooth surface that the sand cushion gives and is considerably more costly. The sand filler in the joints allows moisture to be absorbed in the pavement, and ultimately this moisture gets into the blocks and trouble ensues. It is only on extremely heavy traffic streets that sand can be used as a filler without expecting some expansion difficulties sooner or later. The proof of the pudding is the eating, and the proof of theories of wood block construction lie in the actual occurrences on the street.

* Read at the annual meeting of the American Wood Preservers' Association, Jan. 22nd, 1914.

MAINTENANCE OF ENGLISH ROADS.

Although the following figures relate to the mileage and cost of maintenance of English roads are for the year 1911, they will be found interesting nevertheless by men in highway work. They appeared recently in connection with the British taxation returns.

It will be seen that the total mileage of roads in England and Wales in 1911 was 150,671, of which 27,754 miles were main roads, the cost of maintenance and repair of which amounted to $14,365,750. Some 122,917 miles were ordinary or district roads which cost, in maintenance and repair for the year, $28,396,000. These sums are exclusive of works of road improvement, and if such be added the total outlay on the roads for the year under review was $73,862,000.

Description of Roads.	Mileage Year 1910-11.	Expenditure on Maintenance and Repairs 1910-11.	Average Per Mile. 1910-11.	Average Per Mile. 1909-10.
1. Main roads repaired by County Councils:				
(i.) In urban districts	631	$[illegible]28,8[illegible]3.64	$1,156.08	$1,108.08
(ii.) In rural districts	17,723	7,594,036.74	427.68	388.80
2. Main roads repaired, on behalf of County Councils, by Councils of:				
(i.) Municipal boroughs	1,243	1,368,532.26	1,103.22	1,074.06
(ii.) Urban districts other than boroughs	2,315	2,375,533.98	1,025.46	967.14
(iii.) Rural districts	5,842	2,298,726.59	393.66	364.50
3. Roads (not being main roads) repaired by Councils of:	4,871	2,626,062.12	539.46	515.16
(i.) Municipal boroughs	11,411	4,712,275.44	413.10	370.08
(ii.) Urban districts other than boroughs	95,077	11,239,158.24	116.64	111.78
(iii.) Rural districts	9,366	6,257,133.36	665.82	631.80
4. Public roads and streets repaired by:				
(i.) Councils of county boroughs	2,144	3,387,084.66	1,579.50	1,545.48
(ii.) Councils of metropolitan boroughs	48	174,289.32	3,630.42	3,965.76
(iii.) Corporation of London				
Total	150,671	$42,761,706.30		

HAMILTON WEST END SEWAGE DISPOSAL WORKS

DESIGN AND CONSTRUCTION DETAILS OF THIS PART OF AN EXTENSIVE SEWERAGE SYSTEM FOR ENTIRE CITY—OUTLINE OF THE SYSTEM AND ITS CHIEF COMPONENTS

By BERNARD E. T. ELLIS, C.E.

Assistant Engineer, in charge of Main Drainage Works, Hamilton

THE City of Hamilton, with a population of over 100,000, is situated at the head of Lake Ontario. The sewers are all on the combined system, as a result of which the discharge of sewage fluctuates considerably. The topography of the city is such that at least two main outfalls are necessary, owing to the Dundurn Ridge, which runs north and south, dividing the city into western and eastern drainage areas, which may be classed as residential and manufacturing districts respectively. In 1911 the west end main trunk sewer was built to calculations for the combined system of drainage, with a maximum drainage area of 1,225 acres.

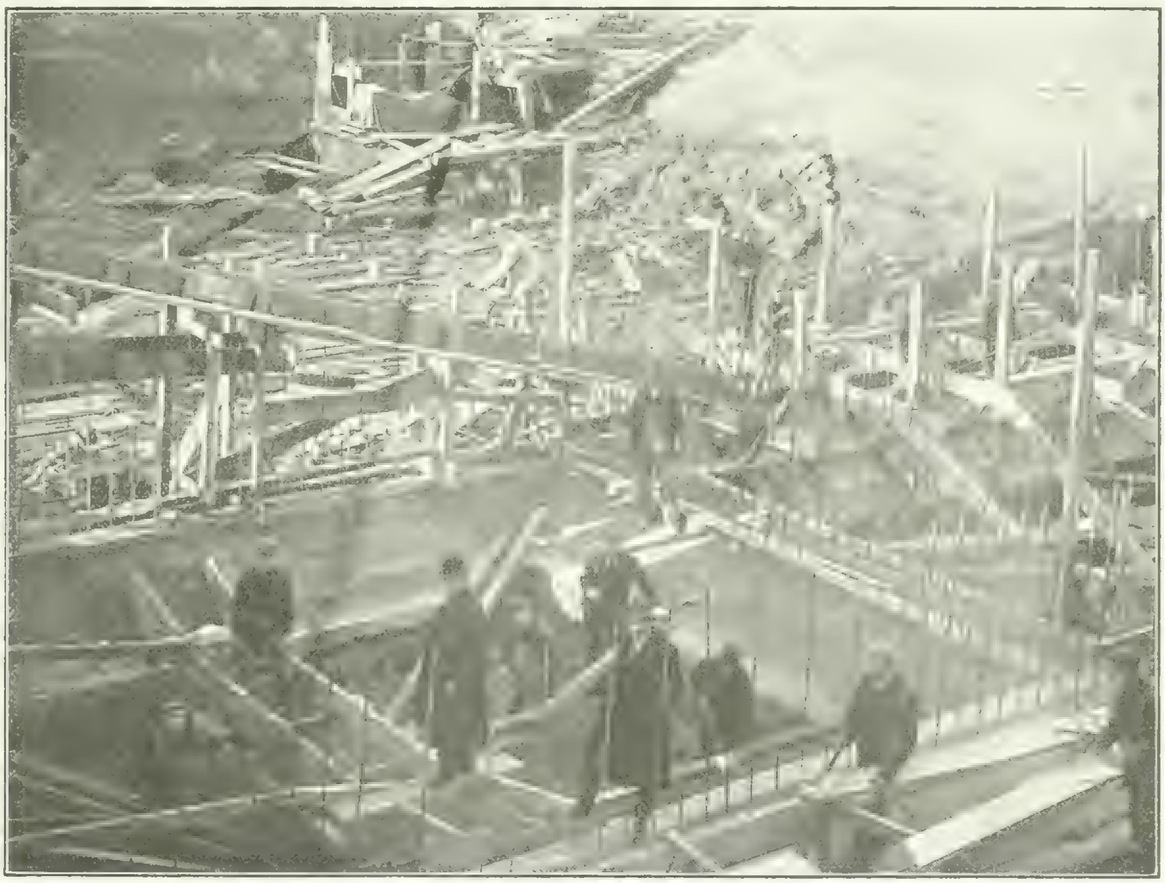


Fig. 1.—Sedimentation Tank Bottom and Sump Under Construction; Clear Water Drainage Scheme.

Upon this area the calculation for these disposal works was principally based. Allowing, for the area being fully built upon, owing to the rapid growth of the city, a total daily dry-weather flow of 5,880,000 gal. of sewage was the volume considered for treatment. Calculations from weir gaugings, taken at the outfall in the main sewer, gave the present daily dry-weather flow to be approximately 3,000,000 gal. In character the sewage to be treated is purely a weak domestic one. As it is to be carried to the disposal site by gravitation, in sewers having sufficient grade to ensure a good self-cleaning velocity, it will be discharged at the works in a comparatively fresh condition.

The new disposal works were designed to treat the sewage from this entire west end drainage area. They comprise: coarse screens; grit chambers; continuous flow, 2-story sedimentation tanks; dosing chambers; sprinkling filters, provided with nozzles, throwing a circular spray under a variable head given by the dosing chambers. Fig. 2 shows the general layout.

For the present, only part of the original scheme is being carried out, to remove the suspended solids from the whole of its sewage, to reduce the bulk by septic decomposition. The final treatment of the clarified effluent by filtration, after further consideration was abandoned, as the effluent discharging in a marsh as a considerable distance from its inlet through the Des Jardines Canal to the Bay, was considered to be sufficiently oxidized before reaching it. The secondary filtration may be added at some future date if found necessary by local changes in the district.

Treatment of Sewage—Main Intake Chamber. The main intake chamber off the 6½-ft. main sewer leading into the site of the disposal works was designed with a storm overflow weir, at such an elevation that during storms anything above 3 times the normal dry-weather flow would discharge over it, into the existing brick sewer, which is at present the main outlet for the untreated sewage from the West End drainage area into the marsh. The connections are shown in Figs. 3 and 4. When the new disposal plant is in full operation this old brick sewer will act as a storm overflow sewer only.

The end of this chamber is constructed as an inspection manhole, fitted with sluice gate for closing down the works whenever necessary.

Screening Chamber.—The C.I. screen consists of bars spaced at ½-in. centres, placed at an angle of 45° to the flow, and only intended to arrest the bulky floating mineral matter, which can easily be removed, by means of hand raking, into the steel channel iron supporting it.

Grit Chambers.—The grit chambers, as shown in Figs. 6 and 7, are built in series of three, each 30 ft. x 4 ft., and a variable depth (minimum being 4 ft.). They are equipped with a by-pass arrangement, controlled by penstocks for diverting the flow as required when in operation.

The normal velocity of these grit chambers is calculated for not less than 1 ft. per sec., and stop-logs have been inserted in the main walls to regulate the velocity according to the variable flow. They were designed with the object of being operated separately. They are not intended to remove putrescible organic matter, but simply for the settlement of sand, and any other heavy mineral matter. A large percentage of streets drained in this district are at present paved with macadam, and, being on the combined sewerage system, a considerable amount of sand, silt, and street washings will find its way into the sewers after heavy storms.

The cleansing of these chambers may be done whenever required, being easily accomplished in the following manner: The sewage is drained off by means of the 6-in. unjointed, vitrified pipes, covered with broken gravel, laid in the V-shaped channels, leading from a main sump to the manhole where each draw-off pipe is fitted with a separate valve. This manhole is connected to the temporary 9-in. effluent pipe, through which the sewage is discharged to the main effluent pipe emptying into the marsh. The chambers are then cleaned out by hand. It is intended to use the sand, after washing (if necessary) for the finished layer required on the filter media for the sludge beds.

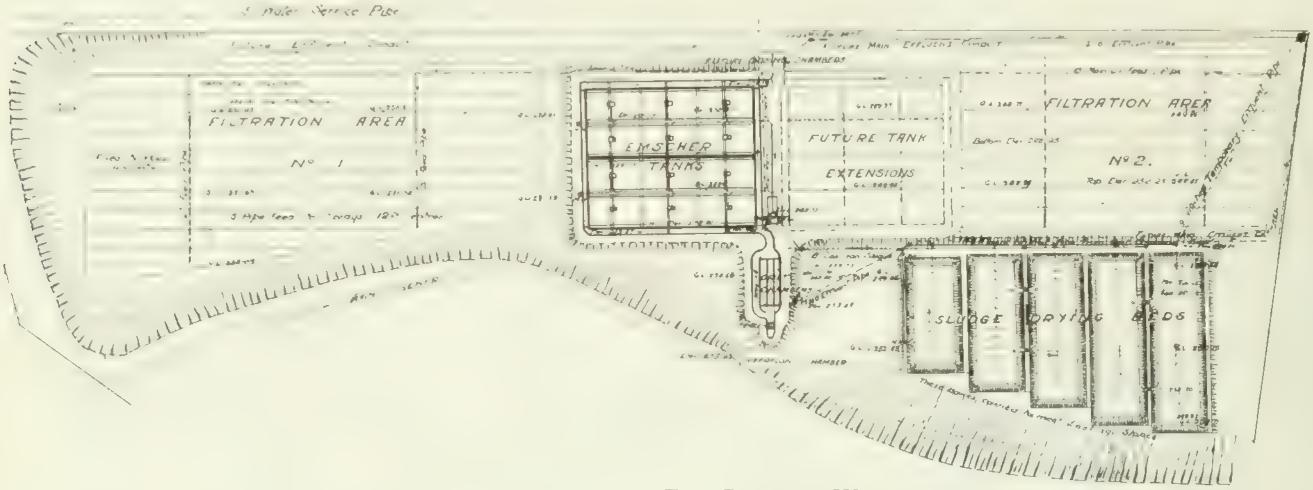


Fig. 2.—General Layout of West End Disposal Works, Hamilton.

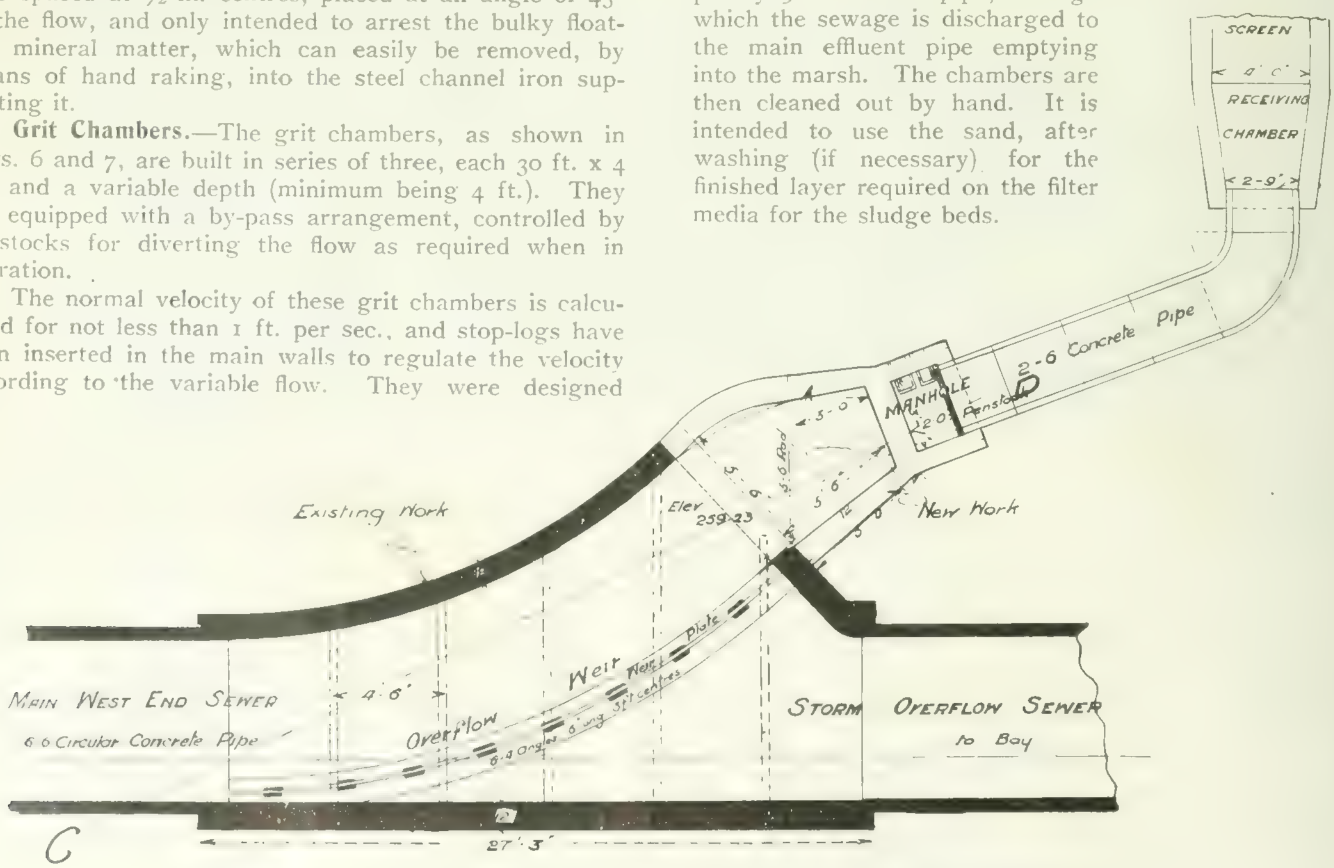


Fig. 3.—Plan of Overflow Chamber and Connection to Tanks from Main Sewer.

porary 9-in. effluent pipe, through which the sewage is discharged to the main effluent pipe emptying into the marsh. The chambers are then cleaned out by hand. It is intended to use the sand, after washing (if necessary), for the finished layer required on the filter media for the sludge beds.

Sedimentation Tanks.—After depositing the mineral matter, the sewage passes along the feeder conduits to the 2-story sedimentation tanks, and by means of the different gates located at the positions shown in Fig. 5, scum boards at both ends into the clarified effluent conduit, which discharges into the main effluent pipe leading to the marsh.

Each tank is rectangular in shape and consists of a sedimentation tank and a sludge digestion chamber. The one is separated from the other by means of a reinforced concrete sludge apron, at an angle of 60° to the horizontal in order to facilitate the automatic discharge of sludge into the lower compartment. These overlap each other, and have an 8-in. horizontal opening, which is

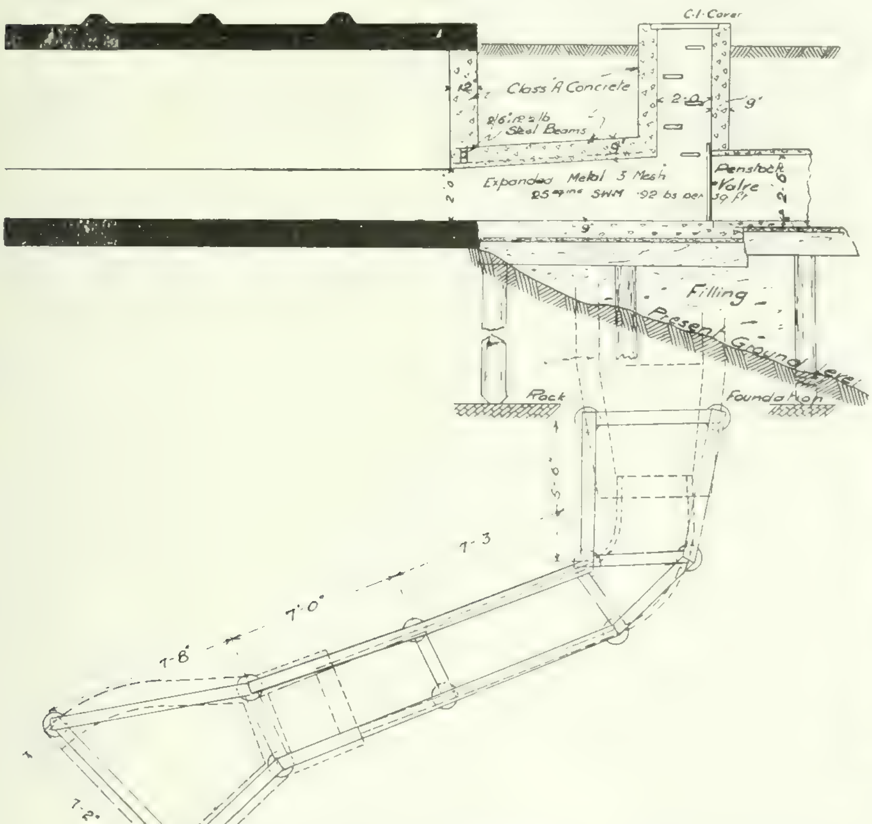


Fig. 4.—Section Through C.D. (Fig. 3), Also Plan of Piling for Supporting Connection (Lower).

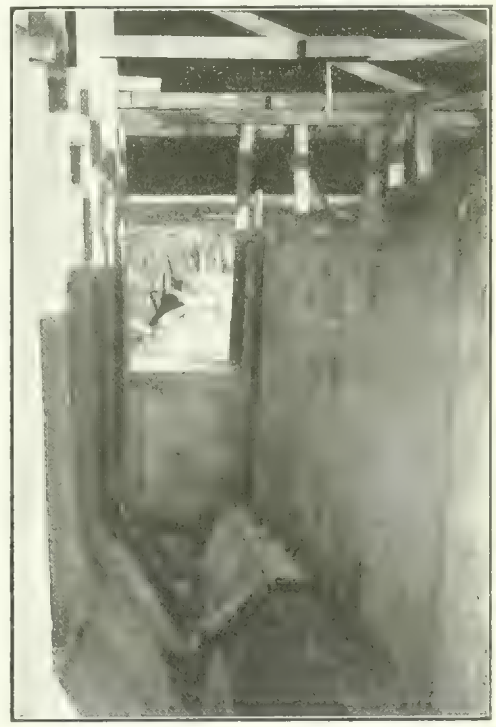


Fig. 5.—Showing Formwork and Drains; One Grit Chamber Under Construction.

the direction of sewage flow can be reversed, that is, fed from either end of the tanks, every month, or as required. By this means it is possible to equalize to a large extent the depth of deposited sludge in all 3 digestion chambers before cleansing has to be undertaken.

These tanks are in series of four, split up into 3 digestion chambers to each tank, and the sewage passes over a weir the full width of the tank, to insure a uniform flow of sewage, and thus eliminates any dead space in the upper compartment, and passes under supported by means of reinforced concrete beams having their supports on the walls, dividing the sludge digestion chambers into three. They are carried up and act as baffles to the upper compartment, which assists considerably the lighter solids to deposit on the inclined aprons, and slip down into the lower sludge digestion compartment, staying there until decomposition is complete. The cross-section shown in Fig. 9 illustrates the above features.

To minimize the passing of gases from the lower to

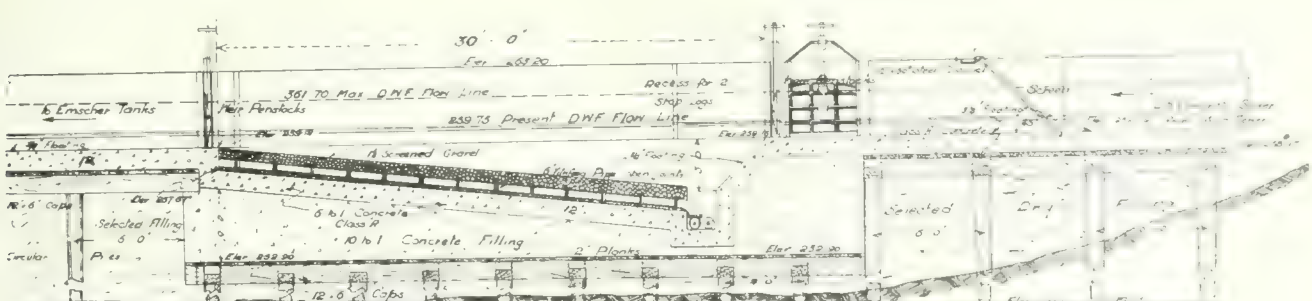


Fig. 6.—Longitudinal Section of Grit Chambers.

the upper compartment, and to adequately provide for ample ventilation for the many gases given off due to the putrefactive decomposition of the settled solids, which goes on continuously until cleansing times, these aprons were placed at a minimum space of 15-in. from the main walls, which should allow for the clogging and

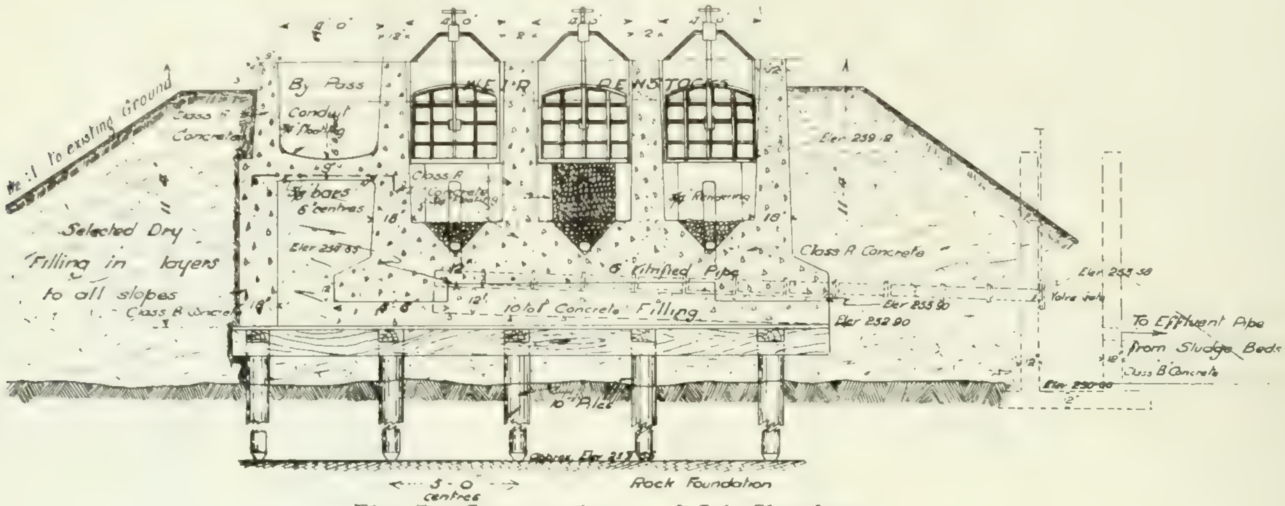


Fig. 7.—Cross-section of Grit Chambers.

scum formed. This scum would otherwise block up the smaller spaces and prevent the ventilation which is absolutely necessary for the efficient working of the two compartments.

These tanks were designed for an average velocity of 1.75 ft. per min., with a retention of 2½ hr. (assuming the hourly flow as 1/18th of the daily flow). The upper compartment is well baffled to assist the settling


Fig. 8.—Grit Chambers Under Construction—Showing Formwork, Etc., and General Method.

capacity, and all exposed surfaces are rounded off to prevent sludge deposits.

The sludge digestion chamber, owing to local conditions as to foundation, expense of construction, and efficient working depth of tanks (for better sludge results), was designed for 5 to 6 months' storage capacity. The bottom slopes to a central 3-ft. square sump at variable inclinations, the minimum being 2 ft. horizontal to 1 ft. vertical.

The sludge removal pipes are C.I., 8 in. diameter, and have an outlet connection 6 ft. below the flow line of the upper compartment. Thus on opening the gate, the sludge flows by gravity up the central vertical sludge pipe into the main C.I. pipes, laid to a minimum grade of 1 in 30 in the main divisional walls. It discharges into a small collecting well in the pump house. It is then raised by means of a low set force pump (electrically driven) into the distributing chambers feeding the different sludge beds.

The vertical 8-in. C.I. flanged sludge pipe commences at the small sump, and has a special 12-in. bellmouth casting resting on a 3-legged cast iron support; it has a clearance of at least 1 ft. all round the small sump, which affords a free entrance with ample depth to ensure a speedy removal without clogging. The operation is materially assisted by water jets from a lead pipe running entirely around the sloping sides of the digestion chamber, about one-half way up. This pipe is drilled with ⅛-in. holes at 15-in. centres. On the digestion tank being emptied, the valves regulating the sludge pipe and water service are opened, ensuring a thorough agitation of all the sludge in the digestion chamber to be emptied. In this way the chamber is efficiently cleansed, overcoming the obvious evil of the old sludge being left around the sides of tank, and the new sludge working down from the top. In the latter case the operation would clean out only a small pocket around the vertical sludge discharging pipe, and (besides leaving behind the old sludge) would considerably reduce the capacity of the digestion chamber, unless cleansed by hand labor, which owing to depth, etc., would prove a costly item.

Another important drawback is the constant clogging-up of the sludge discharging pipes, which, I think, has been remedied in a scheme whereby the horizontal C.I. pipes, connecting the vertical sludge discharge pipe with the main discharge pipes in divisional walls, are laid at a grade of 1 in 36. The main discharge pipe is also connected to the sedimentation tank by means of a valve connection, so that after each digestion chamber has been emptied, by opening the valve the pipes can be flushed out by the sewage in the upper compartment under a 6-ft. head of tank sewage. In addition to these arrangements all the extreme ends of the vertical and horizontal sludge discharging pipes (wherever possible)

are carried through the walls into inspection manholes, and fitted with a fire hose connection for cleansing purposes. Sufficient space is left for rodding, general cleansing, and inspection purposes. Manholes, carried

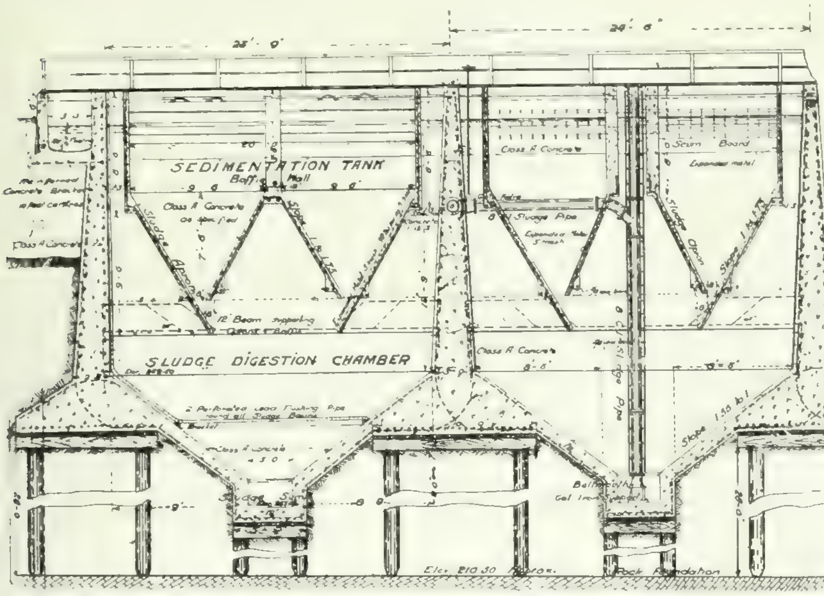


Fig. 9.—Cross-section of Sedimentation Tank (Emscher).

on reinforced concrete brackets from the baffle walls, are constructed to each tank, which are provided with W.I. built-in ladders, to facilitate the proper inspection of all parts of the tank under cleansing periods.

Sludge-Drying Beds.—The sludge-drying beds are of earthwork construction, in series of five of varying length, with a standard width of 25 ft. They are underdrained with 3-in., unjointed, vitrified pipes, laid at 6 ft. centres, and at an angle of 90° to the main 6-in. vitrified pipe. This pipe discharges into the 9-in. temporary effluent pipe, joining the main effluent discharge pipe in the manhole, as shown in Fig. 11.

At the junction of the 9-in. effluent pipe and main carrier from each bed, an open manhole is constructed, to provide for ample inspection of the water from the sludge beds, which will pass directly into the marsh.

These filters have a minimum depth of 12 in. of graded gravel, with a 1-in. layer of fine sand. Under each sludge discharging trough a concrete apron will be constructed to prevent damage to the filtration surface in times of operation.

The sludge is discharged into the different C.I. branch pipes leading to each bed by means of valves and movable wooden troughs from the distributing chambers to the beds. It is then spread over the filtration surface to a depth of approximately 1 ft., and, according to weather conditions, is spadable in 3 to 4 days without nuisance or smell.

Manholes are constructed at each branch feed pipe on the 8-in. C.I. main rising from the pump house to the sludge beds and all necessary valves. Inspection boxes are fixed for rodding and cleansing purposes.

The filtration area of these beds was calculated for 550 sq. ft. per 1,000 population, as the combined sewerage system is in vogue in the West End district.

General Construction Details.—The site purchased for the disposal works was in low-lying ground, its level being approximately 5 ft. above the level of the Bay. The geological formation consisted chiefly of stratas of very wet, blue and brown clay, intermixed with fine gravel. The 3-in. auger borings taken for guidance to the tenderers, indicated rock at 22 ft., but on excavation it was found to be a thin strata of hardpan, varying from 1 to 2 ft. thick. This discovery necessitated a complete change in the foundation plant.

The originally intended concrete piers under the walls and sumps were discarded in favor of pile foundation which, to safely withstand the load, called for 12-in. piles, 30 ft. long.

The whole of the works, owing to the low-lying nature of the site, and the difficulty of providing sufficient head to operate successfully the fixed sprays intended to be used for future filtration beds, had to be built on a trestle pile foundation in reinforced concrete.

On account of the spongy nature of the soil, together with the fact that the low elevation of the sump bottom is 14 ft. below lake level, a great amount of water had to be contended with. This rendered the excavation, setting out, pile driving and general foundation work a little more difficult to accomplish; and, as the sides of the excavation were sloped back without sheet piling or timbering of any kind, a great deal of extra excavating and filling-in had to be done owing to sides continually caving in. This, together with the

Fig. 10.—Method of Running Concrete from Mixer. Also Shows Reinforcement in Main Walls.

previously mentioned conditions, seriously retarded the quick progress of the work.

The structural walls and sumps are built of Class A concrete (4, broken stone of 2-in. gauge : 2, sand : 1, Portland cement), reinforced with ¾-in. and ⅝-in. commercial round steel rods. Expanded metal was used in the sludge aprons.

The interior concrete work of the tanks, as will be noted from the accompanying illustrations, although of a complicated nature, furnished no special engineering difficulties, except some intricate form work, which is shown in part.

The works were designed by the author as a part of an extensive scheme to solve the sewage problem for the entire city, including an east end disposal plant and main drainage system, and a storm overflow sewer to relieve the central area of the city in storm time. All these works have been designed and approved. The west end development, described above was commenced in July, 1913, and is being carried out by the city, whose tender of $63,000, not including C.I. pipes, valves, etc., was considerably lower than the next of five competitors. The work is being done by day labor.

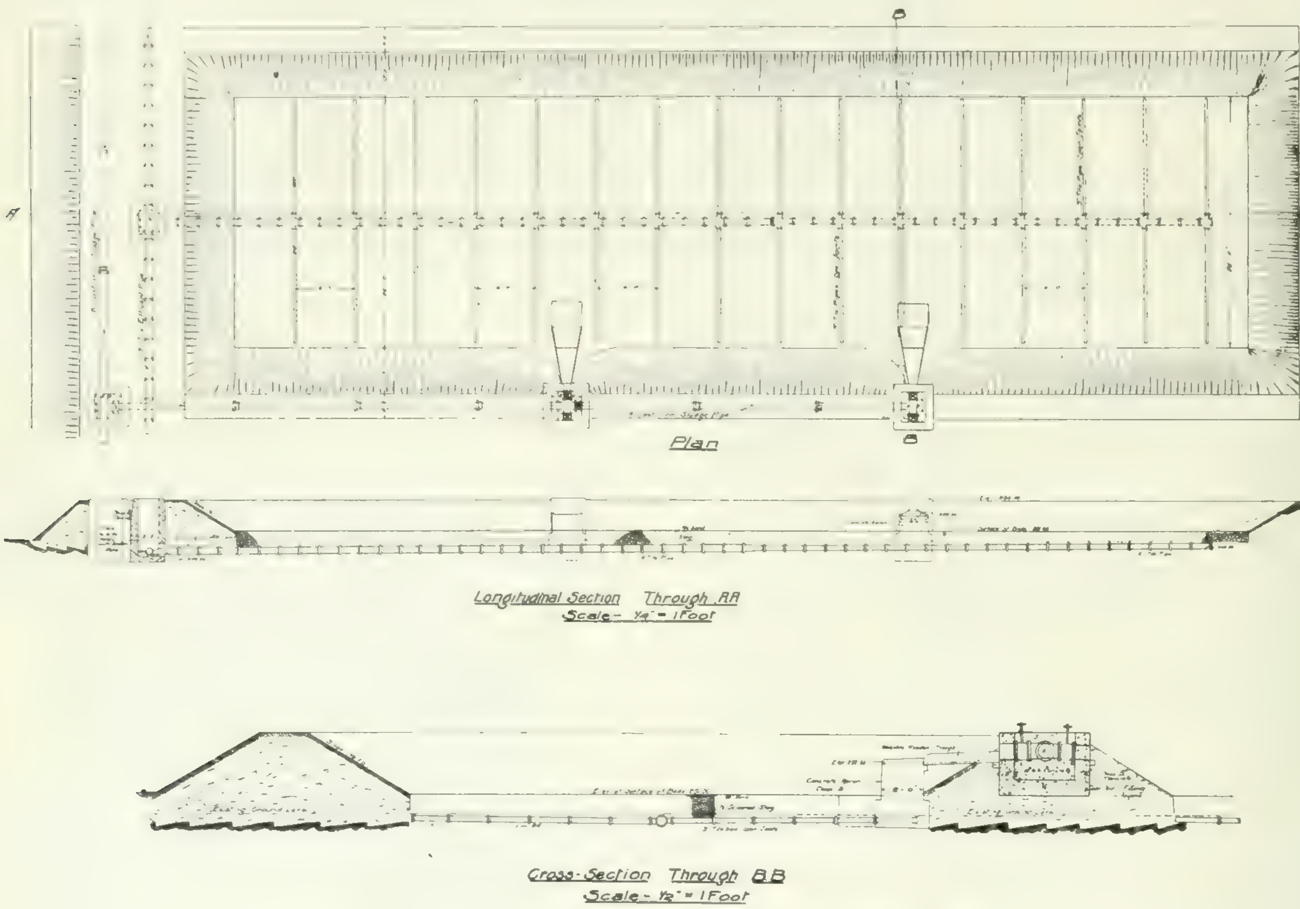


Fig. 11.—Plan and Sections of Sludge-drying Beds.

Late in the fall operations were discontinued, owing to severe weather. Construction is well under way, and should commence in the early spring.

The author has acted as engineer-in-charge, under the direction of A. F. Macallum, C.E., City Engineer.

IRON AND STEEL PRODUCTION IN ITALY.

The completed statistics of the production of iron and steel in Italy, for 1912, have been announced. The production of iron ore was 582,066 tons, which compares with 373,786 tons in 1911 and 551,259 tons in 1910. Imports of iron ore in 1912 were 18,551 tons and exports were 12,313 tons. The production of manganese ore was 2,641 tons. There was also produced 248,612 tons of iron pyrites, of which only 2,144 tons were exported, while 70,762 tons were imported.

The make of pig iron and direct castings in 1912 was 418,675 metric tons, which compares with 342,586 tons in 1911. The output of steel ingots, largely from imported pig and scrap, was 922,000 tons, a gain of 186,000 tons over 1911. The production of wrought iron from pig was only 1,500 tons, but there was a large quantity made from scrap, some of it imported material.

The total production of finished material was as follows, in metric tons:—

	1912.	1913.
Wrought iron	303,223	179,516
Steel	697,958	801,907
Total	1,001,181	981,423

The principal items of finished steel in 1912 were 392,263 tons of bars and shapes, 130,067 tons rails and 89,905 tons of plates and sheet. The output of tin plates was 28,916 tons.

In 1912, there were in operation in Italy, 64 open-hearth furnaces, two Bessemer converters, two Robert converters, five electric furnaces and two crucible furnaces.

The Canadian Engineer

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CONTENTS OF THIS ISSUE.

ANNUAL MEETING—CANADIAN SOCIETY OF CIVIL ENGINEERS.

The twenty-eighth annual meeting of the Canadian Society of Civil Engineers will be held in Montreal, January 27th, 28th and 29th. A detailed programme appeared in last week's issue of *The Canadian Engineer*. It includes the presidential address, the election of officers and members of Council for 1914, the reception of the report of Council, the reception and discussion of the reports of the various standing committees, and the transaction of general business of the Society. A visit to the works of the St. Lawrence Bridge Company at Rockfield will form a part of the second day's proceedings. The annual dinner of the Society will be held in the Engineers' Club on Wednesday evening.

Every engineer belonging to the Society, whether to the class of member, associate member, or junior member, should be in attendance, and it remains for each to make all possible effort in that direction. Each member is a unit in the organization representing the engineering profession in Canada, and this evolves a sense of duty to exercise his initiative and influence in the unifying and strengthening the forces working among these 2,700 engineers for the betterment of his profession.

A society does not need to be of a highly specialized nature to find plenty of important and labor-requiring work for it to do. Specific problems in various engineering lines are accumulating, and the conscientious work of committees will bring even greater results and speedier solutions if the committees have behind them a willing co-operation and a desire on the part of the members of such a society to be of as much assistance as they can. Besides, each member must feel that his part should become, in early years, if it is not the case now, one of activity in the direction of the tendencies of the profession and of the representative society.

A good deal will develop in the course of the coming meeting of the Canadian Society of Civil Engineers to recompense any member for what sacrifice of time and business he may find it necessary to forego in order to spend January 27th, 28th, and 29th in Montreal.

BOUNDARY WATERS AN UNSAFE SUPPLY UNLESS TREATED.

A report laid before the International Waterways Commission last week has to deal with the sewage pollution in the boundary lakes and rivers between Canada and United States. The conditions which obtain in all localities, from Rainy River to Cornwall, with the exception of the already investigated waters in the district around Toronto, come within its scope.

It is observed that every municipality within the area investigated, on the Great Lakes and their connecting rivers, avails itself of the opportunity open to it of discharging its sewage in an untreated state into these waterways. Navigation has likewise been the cause of dangerous pollution in some localities, while the run-off from surrounding watersheds during spring floods adds materially in that season.

The results of the investigation indicate that there is not a municipality using these boundary waters as a source of supply, that is immune from danger of waterborne diseases, unless the supply is previously treated. It is claimed that the high death-rate from typhoid, along the boundary, has been directly due to 3 conditions, viz., unrestricted discharge of sewage; failure to purify the supply; and inefficiency of purification.

Although the report makes no formal recommendation, leaving that for the Commission to embody in its report to the two Governments concerned, it clearly shows the need for legislation and restrictive regulations that will require all municipalities dumping sewage, directly or indirectly, into boundary waters to previously subject it to a purification process. It also points to the advisability of a careful purification of every water supply, demonstrating that the presence of pollution for but a few days is a serious menace to public health.

CONTRACT vs. DAY LABOR IN MUNICIPAL WORK.

The engineering departments of a number of our cities have found it good policy to carry out their civic extensions, such as pavements, sewers, distributing water mains, etc., themselves. These cities have developed quite an extensive plant which enables them to carry out such work efficiently. With such plants well located and working under good organization, these improvements can be done at a figure against which contractors cannot compete, and make a reasonable profit. General construction work, however, is largely open to competitive tendering, the city engineer submitting a bid, allowing, of course, a fair margin of profit on each of his tenders. On such work, it is found that contractors are often in a position to underbid the city engineering department, sometimes to the extent of 25%. With properly qualified and adequately paid inspectors, such work is done better and cheaper than the municipality could do it. Besides, the city engineer, already overburdened, is not carrying the additional responsibility and is enabled to better superintend the details of construction of the work which his department is doing. This is largely owing to the fact that the average city cannot keep up an organization to the same efficiency as a contractor's organization. It is not sufficiently elastic to handle the variation in quantity of work which develops in a growing city of any size. Again, a city finds itself handicapped in obtaining and retaining the most efficient foremen and laboring men. Our cities are subjected to a climate that curtails civic work in winter, and foremen cannot be given work the year round. This gives the wide-awake contractor an opportunity to secure the good foremen from the city forces, and to retain them by paying them better than the average city engineer is permitted to do. Generally speaking, our cities pay the lowest wages, resulting in more expensive and less satisfactory work.

It would appear that our cities are materially benefitted by subjecting all their work to competitive tendering. Notwithstanding the fact that the city engineering department generally secures those improvement works for which it is specially adapted, the competition gives the contractors their chance of tendering, thereby removing an important stumbling block that public opinion frequently finds in the foreground of the civic administration. It also adds a certain stimulus to the city engineering staff that is important. Otherwise the city, because of the fact that low wages are paid, builds up a laboring force of a class of men to which few other employers would give work for the simple reason that they are not worth what they have to be paid. Such men, regularly employed by a city, get an idea in time that the city is bound to provide work for them. The constant stimulant afforded by the competition of tendering, prevents such deterioration of organization. This prevents the involved increase in the cost of work. It also establishes a formidable reason for the employment of the best men, paid accordingly.

TORONTO WATERWORKS EXTENSIONS—THE OLD REPORT AND THE NEW.

The question of water supply gets little rest in the City of Toronto. For years civic authorities have studied over it unceasingly, and the citizen has frequently had cause to assume a share of the worry when his business or his household was jeopardized by uncertainty or unsuitability of supply.

Our readers will remember the 1912 report of a Board of Water Commissioners, which recommended as a solution to the problem, the installation at Scarborough Heights of an intake, tunnel, filtration plant, and reservoir, with gravity feed mains to the city. The proposal evoked an editorial discussion in these columns prior to the submission of a by-law to authorize the necessary expenditure. This discussion included many criticisms, chief among which being:—

(1) That, since Lake Ontario water as a Toronto supply must necessarily undergo filtration before use, the quality of the water off Scarborough did not justify the heavy expenditure involved in bringing it 12 miles to the centre of the city, or in serving West Toronto from such a distant source.

(2) That pumping the supply to a height of 370 feet into a reservoir on the Scarborough plateau was unnecessary, and meant greater cost of construction and a heavier continuous cost of operation, a considerable percentage of the head thus acquired being lost in the gravity flow mains to the city.

(3) That to guard against interruption of electrical operation of pumping station by using an independent electrical supply, preferably from the Trent Valley or some other source, to supplement Niagara power, was not adequate provision. The difficulties of electrical supply being mainly those of transmission, a storm which would cause interrruption of service on the Niagara line would probably have a similar effect on any other long transmission line.

(4) That the recommendation to duplicate the slow sand filtration plant on the Island was not warranted by its performance, and that the proposal of a mechanical filter at Scarborough and a slow sand filter at Toronto Island to treat water of practically the same quality was anomalous.

(5) That the estimated cost, $5,320,000, was much too low, to carry out the work proposed.

The Canadian Engineer strongly voiced its belief that the Scarborough scheme was not an adequate return for the amount of money which the citizens of Toronto would be asked to spend, as it did not assure an abundant supply of pure water at the lowest possible cost.

With the report open to such criticisms as these, the by-law which was submitted to the ratepayers on Jan. 1st, 1913, did not specify the nature of the waterworks extension. It read: "for additions and extensions to the waterworks pumping and distributing plant." It carried, authorizing an expenditure of $6,677,000. Unsatisfied with the report, the city proceeded forthwith to investigate the whole problem for itself, and the new report is the outcome.

It is interesting to read the criticisms of the old report that are embodied in the new.

REPORT ON PROPOSED EXTENSIONS OF TORONTO'S WATERWORKS SYSTEM

EXTRACTS FROM REPORT RECOMMENDING A 60,000,000 GALLON PER DAY ADDITION OF MECHANICALLY FILTERED STEAM PUMPED WATER SUPPLY FROM AN INTAKE IN 49 FEET OF WATER ONE MILE OFF VICTORIA PARK—ESTIMATED COST $6,033,700

A REPORT, prepared by the Department of Works of the City of Toronto, and dealing with the proposed extension of the waterworks pumping and distributing plant, is presented herewith in extracted and summarized form. Its chief features are: A forceful condemnation of the Scarborough scheme as recommended in the 1912 report of the Commission appointed by the city in 1911 to investigate the problem; and a proposal covering the installation of a plant at Victoria Park to filter and pump directly into the mains water drawn through a 9-ft. tunnel 2 miles in length from a 110-ft. intake crib in 49 feet of water.

The previous report (extracted in *The Canadian Engineer*, May 30th, 1912) was met with the following summary of essentially questionable features:—

1. The basic information essential to the proper, economical and serviceable design of such a system was not procured.

2. The location, aside from the impossible hydraulic conditions it creates, considered in conjunction with our present pumping system, was ill chosen, and altogether too far east of any probable future centre of distribution.

3. The intake crib proposed, at an estimated cost of $500,000, to be located in 100 feet of water, does not follow proved practice, and is too costly an experiment.

4. A tunnel two miles long, driven to a point where a depth of 100 feet of water is obtained, is unnecessarily long, and no essential purpose is served in procuring such depth of water. The estimate for the tunnel is low.

The depth at which it was proposed to drive the tunnel was so great that if resort to compressed air working became necessary, the tunnel would have to be abandoned.

5. The proposal to install electric pumps without steam reserve, is imprudent.

6. The proposition to pump the whole water supply to a height of 370 feet, when 75% of it need only be

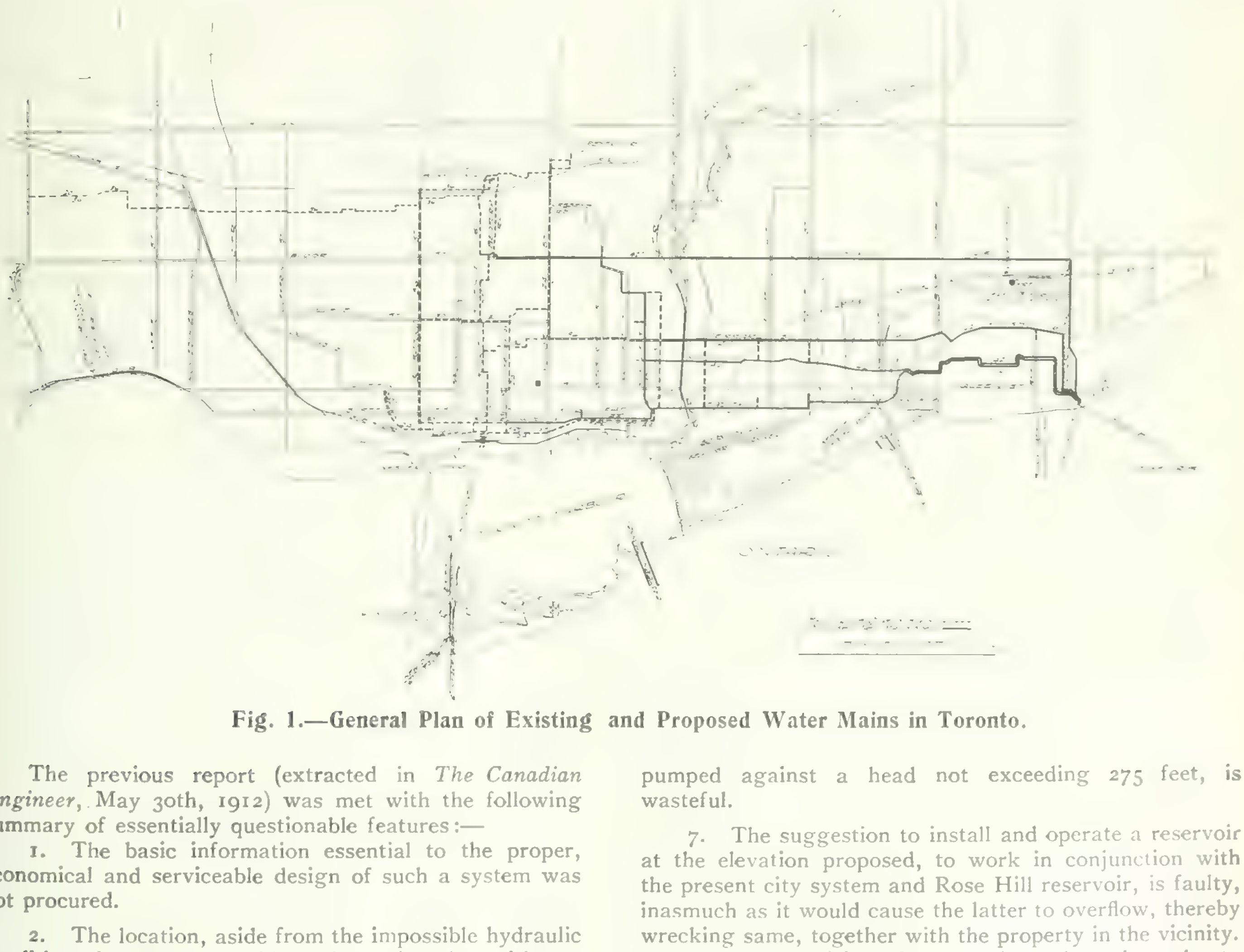

Fig. 1.—General Plan of Existing and Proposed Water Mains in Toronto.

pumped against a head not exceeding 275 feet, is wasteful.

7. The suggestion to install and operate a reservoir at the elevation proposed, to work in conjunction with the present city system and Rose Hill reservoir, is faulty, inasmuch as it would cause the latter to overflow, thereby wrecking same, together with the property in the vicinity.

8. The provision of one steel supply main, only, to the city, is unwise, as in case of breakdown outside the city limits, there would be an entire cessation of supply.

9. The hydraulics of the problem were evidently not carefully considered, and their effect upon the existing system realized, inasmuch as the pressure developed

would render the John Street station, tunnel, filtration plant and intakes useless, unless the aforesaid station was equipped with new machinery, capable of operating against the pressures developed by gravity.

10. The booster stations suggested are unnecessary.

The Proposed Works at Victoria Park.

In the new report, it is proposed to build an intake crib off Victoria Park, 5,100 ft. from shore, in 49 ft. of water. The crib will be approximately 110 ft. in diam., constructed of steel and concrete, and surmounted by a house, the main part of the crib rising 19½ ft. above the lake. The crib will contain the necessary ports for the admission of water.

The inside of the crib will contain a vertical steel shaft, lined with cement or brickwork, running down to a proper depth below lake level, so as to connect with a tunnel 6,380 ft. long, running horizontally to the shore at Victoria Park. The internal diam. of the shaft will be 11 ft., that of the tunnel 9 ft., the latter to have its invert 105 ft. below mean lake level. At the shore, there will be a vertical shaft 10 ft. in diam., rising above the normal lake level at this point. From the vertical shore shaft there will be 2 horizontal 7-ft. tunnels, one on each side and parallel with the shore. One of these tunnels will supply the suction side of the pumps in the station to be erected, the other will act as a reserve to be used in case the size of the station is increased later.

1. A system which will supply an additional quantity of water equal to that now being used during maximum draft, thus practically duplicating the present plant. Therefore, in the event of accident at any time to the sewage purification plant, or either filtration or pumping plants, the use of either plant could be discontinued, and the safety of the supply still maintained. By reason of the proposed plant being a duplicate in capacity of the existing plant, with provision for future increase, the continuity of the supply is assured.

2. A system which will operate in exact harmony with the existing plant, thus enabling both to work in conjunction.

3. An arrangement which can be doubled in capacity without doing unnecessary work.

4. A supply which is unfailing, in so far as human agency can make it. It will not be deleteriously affected by storms, ice, shifting sand, etc.

5. A supply of water, which is as pure as it is possible to obtain in the vicinity of Toronto, and which after treatment will be perfectly safe and satisfactory.

6. An improved service throughout the entire city.

7. An attractive park on the waterfront.

Intake Crib.

The intake crib is in a sense the most important, and, in some ways, the most difficult part of the work. On account of the nature of the elements to which it is exposed, the design should be worked out from the experience of others. Cribs

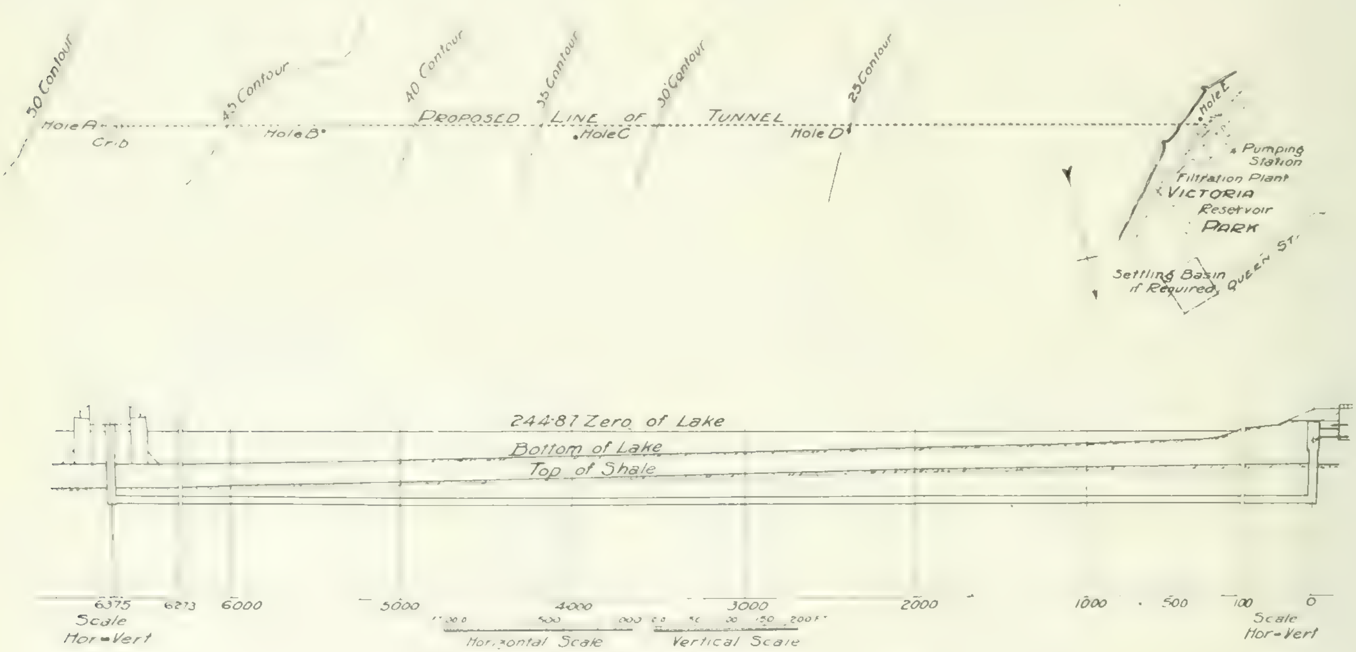

Fig. 2.—Plan and Profile of Proposed Tunnel.

The pumping station will be located in Victoria Park, which, with a piece of land to the east, is of sufficient size to contain a station and filtration plant of a capacity of 120 million Imp. gal. per 24 hr., should such capacity ever be required.

The pumping station will have a capacity of 60 million Imp. gal. per 24 hr., but is being so designed that this may very easily be increased to 120 million gal. if desired. Since the water will have to be filtered, the station must be divided into 2 parts, viz., low-lift and high-lift, the former taking the water from the tunnel shaft and delivering directly to the filters, while the latter will deliver the filtered water direct to the city mains. Each part will have a capacity of 60 million Imp. gal. The low-lift pumps will work against a head of approximately 75 ft., while the approximate head on 3 of the high-lift pumps will be 220 ft., or 95 lbs. per sq. in., and that on the fourth pump about 315 ft., or 137 lbs. per sq. in. The exact pressures against which the low-lift pumps will have to work cannot be determined until the make of filters is known.

The mechanical type of filter is recommended, and in connection with this it is proposed to install a reservoir with a capacity of 2½ million Imp. gal., and to provide space for a settling basin should the make of filter require it.

From the station, four 36-in. pipes will deliver water to four new 42-in. mains which join the present distribution system.

In short, the plan contemplates:

have been constructed in the lakes by various other cities; at Buffalo the crib is 110 ft. diam. in 18 ft. of water; the Cleveland crib is nearly 5 mi. from shore in 49 ft. of water, and is 100 ft. in diam. Chicago has 6 cribs of varied construction, some with surrounding breakwaters, and the latest designed without. Of the latter, the Harrison crib is 112 ft. in diam. and is in 34 ft. of water, while the new Dunne crib is 111 ft. in diam. and in 33 ft. of water. The Milwaukee crib is under 60 ft. in diam. and is in 25 ft. of water, but from a study of conditions, it appears to be inadvisable to adopt so small a size.

From a study of the experience of these cities, it is concluded that the Toronto crib should be 110 ft. diam.

The depth of water in which the crib can be set depends upon the method of placing it, and the forces to which it will therefore be subjected. This crib, made of a steel shell, will be constructed in the harbor and floated to the desired location and sunk. On account of the depth of water in the bay, the shell could not be floated to a greater depth there than 17 ft. It is clear that the success of such an undertaking will depend, to a very large extent, upon the relative amounts of the shell above and below the water surface when floating, and as the depth below is, in this case, small, the total height of the structure is limited. So far as is known, no city in America has installed a crib under such conditions as those existing at Toronto, in water deeper than 50 ft., the Cleveland intake being the deepest. Since the cost of this part of the work will be

great, and hence any unsuccessful experiment would be very serious, it is not advisable to attempt anything that has not been done successfully elsewhere, so that the depth of water in which this crib will be placed is 49 ft. The water entering such a crib will be quite as good for drinking purposes as if taken at much greater depth.

The intake crib will consist of two concentric steel cylinders, set on end and firmly braced together, so as to be rigid and stiff, the outer cylinder being 110 ft. diam., and the inner 60 ft. diam. Plates set radially between these shells will divide the annular space into compartments, which will be constructed with bottoms so as to make them watertight. The compartments will then be sufficiently filled with concrete to make the draft of the structure 17 ft., after which it will be towed into the desired position and sunk, the lake bottom having been previously levelled and otherwise prepared for its support. After sinking, the annular space will be filled with concrete, and the structure built up above the water to provide living quarters for men, with lights and signals for mariners.

Properly constructed ports in the crib will admit water to the inner 60-ft. well. These ports will be controlled by gates which may be closed at pleasure, but the water will never be pumped from the inside of this well. An arrangement has been provided, however, so that it will be quite possible at any time to pump all of the water out of the tunnel for cleaning or other purposes, should this be desired.

Intake Shaft.

Through the centre of the intake crib, a vertical steel shell will be sunk to a depth to meet the tunnel. This shell will rise inside the crib above lake level, and will have proper openings for the admission of water to its interior; these ports to have gates that may be closed when desired. The material will be excavated from the inside of this shaft, which will be lined with brickwork to finish 11 ft. inside diam.

Tunnel.

A tunnel will be driven between the shore and intake shaft, having an inside diam. of 9 ft. with a brick or concrete lining. As it is possible that compressed air will be necessary in the driving of this tunnel, and in order to make it perfectly safe for workmen, the invert will be not over 105 ft. below the lake level. The length of the tunnel will be about 6,380 ft.

Shore Shaft.

This shaft will be of similar dimensions to that at the intake, but with a diam. of 10 ft. inside the brick or concrete lining. It will be closed at the top, and at 13½ ft. below zero lake level will have two 7-ft. diam. horizontal branches, to which the suction pipes of the pumps will be directly connected. The cover on the shore shaft will be quite high enough to prevent damage from surges in the tunnel, these being very small, owing to the low tunnel velocity of only 1.71 ft. per sec. when delivering 60 million Imp. gal. per 24 hr.

Capacity of Tunnel and Shafts.

With a draft of 100 million Imp. gal. per 24 hr. the loss of head in the tunnel and shafts will be under 2.5 ft., so that the capacity will be much above 100 million gal. if it is desired to increase the demand above this amount at any time.

Low-Lift Station.

The purpose of the pumps in this station is to take water from the tunnel shaft and deliver it to the filters. They will be driven by steam and have a total capacity of 60 million Imp. gal. per 24 hr. The lift at zero lake level may be approximately 75 ft., depending upon the make of filters used. In order to procure the best use of the tunnel, the floor of this station should be at lake level. An excavation will be made and the station built with watertight walls and basement. In order to insure safety, there will be two 48-in. delivery pipes to the filter plant, each conduit carrying away the water from two pumps.

High-Lift Station.

This station will also contain steam-driven pumps, having total capacity of 60 million Imp. gal. per day, three having a total lift of approximately 220 ft., and the fourth with a lift of about 315 ft. The precise lift is yet to be determined. The floor level of this station will be at the ground level of Victoria Park.

Filtered water will be delivered to this station through a single 7-ft. pipe, the suction of each pumping unit being connected directly thereto. There will be 4 separate discharge pipes, each 36 in. in diam., one from each pump, and connected to the distribution system.

Boiler Room, Coal, Storage, etc.

The boiler room will be located between the engine rooms. This arrangement brings the boilers close to all pumps, thus giving good steam connections, and also precludes any interference whatever between the boiler and engine foundations and the water pipes. This latter matter is of the very greatest importance. Much attention has been given to the security of the system, and the prevention of damage to the pipes from any cause. It is essential that they must always be easily accessible for examination and repairs.

The boilers will be equipped with mechanical stokers, and the boiler room will be furnished with coal and ash handling machinery, so as to reduce the cost of operating the plant to a minimum.

Coal will be conveyed to the plant in railroad cars drawn by electric motor, along tracks laid to York Station, a distance of 1½ miles.

The coal bunkers will have a storage capacity equivalent to one week's supply.

Reservoir.

The matter of an additional reservoir is one requiring careful study. There is no convenient location for a reservoir in the eastern part of the city, and it would have to be located far beyond the city limits if placed in this direction.

An additional reservoir for the city of Toronto is by no means essential, and not at all requisite. It is desirable that there should be some water storage to provide for fluctuations in demand from time to time. This storage has already been adequately provided for in the Rose Hill reservoir, which has ample capacity for all the present and proposed pumping equipment, and will readily suffice for the needs of Toronto for some time to come.

Since a proposition has been made to establish a second reservoir in connection with plans of the Commission of 1912, it may be well to point out, that if a second reservoir were to be used on the same supply mains as the present Rose Hill reservoir, then the new reservoir would have to be placed on exactly the same level as that at Rose Hill. If the new one were the higher, as proposed by the Commission, the present reservoir would be flooded.

An examination of the country has shown that to secure suitable land for such a reservoir, it would be necessary to go so far out that much of its effect would be lost. Such a plan cannot be recommended.

The present Rose Hill reservoir has a capacity of 39¼ million Imp. gal., which corresponds to about 20 hrs.' supply at the present average daily pumpage of approximately 50 million Imp. gal., and is quite sufficient to compensate the ordinary fluctuations of discharge, due to fires, excessive heat or cold, and other causes.

It will be interesting in this connection, to give the experience of some of the larger American cities using lake water. Buffalo, with an average daily consumption of 117 million Imp. gal., has a single reservoir holding 98 million gal. or 20 hrs.' supply. Detroit, with an average daily consumption of nearly 88 million Imp. gal., has no reservoir. Chicago does not possess a reservoir. In Cleveland, the average daily consumption is 63 million Imp. gal., and the city is divided up into 3 districts for distribution purposes, there being a reservoir for each district, the largest having a capacity of 67 million Imp. gal. Milwaukee has a present consumption of about 79 million Imp. gal., and is now increasing its pumping capacity, but there is no intention of increasing the capacity of the reservoir, which holds only 17 million Imp. gal., or about 6 hrs.' supply.

The foregoing examples show that Toronto has now a much larger reservoir capacity than many other of the larger cities, the size of reservoirs being evidently largely influenced by local conditions. The experience of the cities quoted, confirms the conclusion otherwise reached, that there is no necessity at present to increase the reservoir capacity for this city.

Distribution System.

From the pump house there will be four 36-in. pipes, with Venturi meters, running a short distance from the station, after which they will be enlarged for distribution purposes, and will feed four 42-in. mains, all of these pipes being cross-connected and controlled by valves in such a way as to make a perfectly flexible arrangement. These four mains will then run across Queen St., their locations being approximately as follows (see Fig. 1):

1. One 42-in. main will run across Queen St., up Victoria Park Ave. to Danforth Ave., along Danforth Ave., over the new Bloor St. viaduct to Bloor St., and along Bloor St. to St. George St. At the corner of Bedford Rd. this main will be cross-connected to the present 36-in. main., valves being provided so that the connection may be closed as desired. For the present this main will be placed on the service of the middle district, and hence the connection at Bedford Rd. will be closed, but should it be desirable to serve the [illegible] district, this valve would be opened, and all connections with the middle district closed.

This main will be used on the middle district, and will, therefore, be connected to the 12-in. main at Coxwell Ave., to

the [illegible] in. main at Broadview Ave., and to a new main included in this project at Sherbourne St. It will also be connected with the 16-in. main on St. George St. All of these connections will have valves.

The discharge pressure on the pumps at the High Level Station supplying the middle district is 65 lbs. per sq. in., and hence, after making allowance for friction and difference of level, the pressure at the Victoria Park Station on the pump supplying the above 42-in. main will be approximately 137 lbs. per sq. in. While this pressure is higher than usual, yet the pipe rises rapidly after leaving the station, and there will be only about 2,000 ft. of it subjected to a pressure of over 100 lbs.

2. The second 42-in. main will run from the park across two lots to Kingswood Ave., then up Kingswood Ave. to Kingston Rd. to Heyworth Cres. to Woodbine Ave., across two lots to Patricia Rd. and through two lots to Small St., to Gerrard St., and then along Gerrard to Sackville St. This main will connect with the 12-in. main on Beach Ave., the 12-in. main on Leslie St., the 12-in. main on Carlaw Ave., the 12-in. main on Broadview, the 24-in. main on Sumach St., and the proposed 42-in. main on Sackville St.

the 12-in. main at Sherbourne St., the 12-in. main at Jarvis St., the 12-in. main on Yonge St., and the 24-in. and 36-in. mains on Simcoe St.

5. In order to make this system most effective, a new 42-in. main will be laid up Sackville St. from the corner of Eastern Ave. and Cherry St. to Wellesley St., thence along Wellesley St. to Parliament St. or Rose Ave., to Howard St., to Sherbourne St., to Bloor St. This main will connect with the proposed new 42-in. main at Cherry St., Wilton Ave., Gerrard St. and Bloor St., but at the latter point there will be a closed valve normally, as the Bloor Street main will work on the middle district. It will also connect with the present system at the 12-in. main on Queen St., the 12-in. main on Wilton Ave., the 36-in. main on Gerrard St., the 12-in. main on Carlton St., and the 12-in. main on Wellesley St.

A study of Fig. 1, showing these mains, and their connections to the present system, will make it perfectly obvious, that this distribution plan will give ample accommodation for the water from the new station to reach all points of the city, and will enable the new station to work in perfect harmony with the present plant.

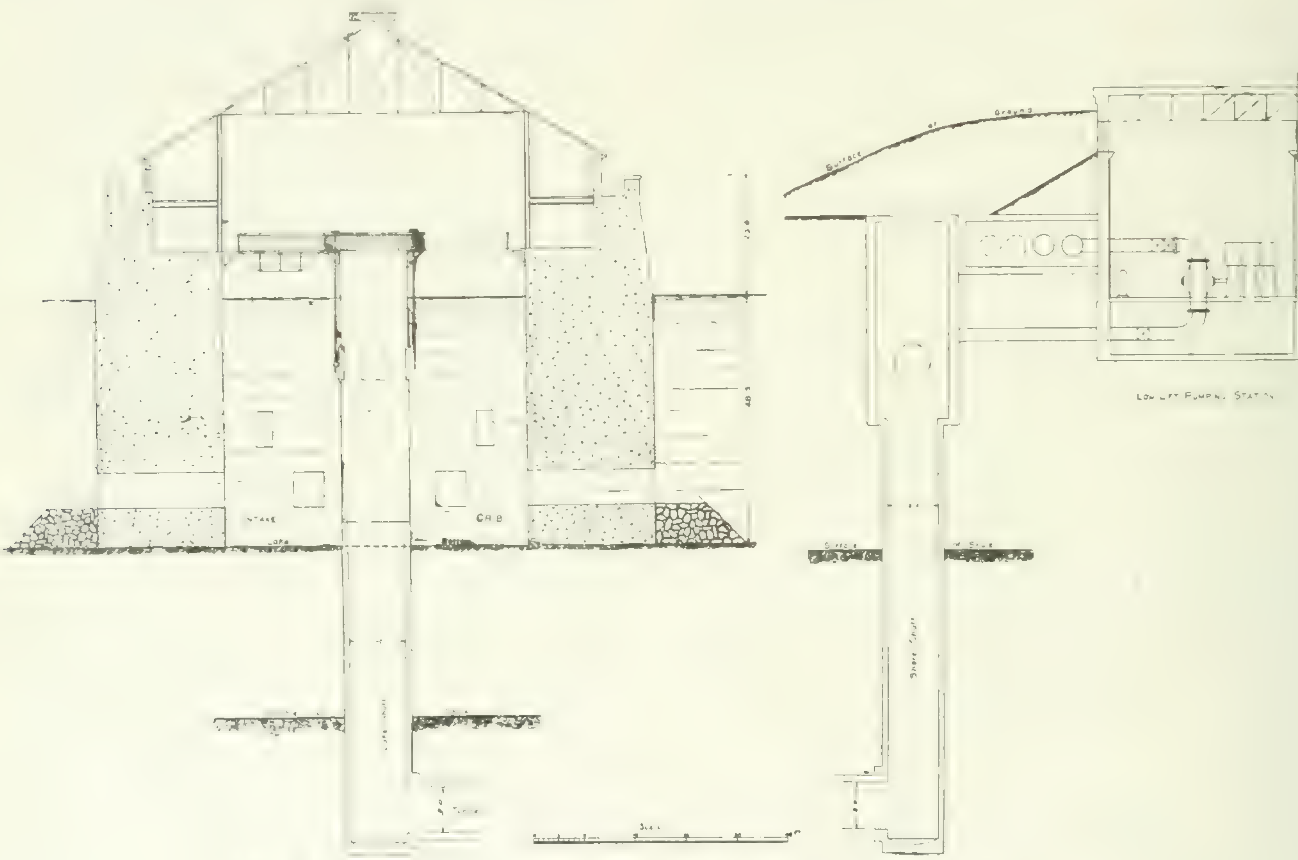

Fig. 3.—Section of Proposed Intake Crib, Lake and Shore Shafts.

3. The third 42-in. main will run from the park across the lots mentioned south of Queen St. to Scarborough Rd., north to Pine Ave., to Balsam, to Pine Cres., to extension of Williamson Rd. to Lee Ave. It will then run north on Lee Ave. to the proposed extension of Norway Pl., along Norway Pl. to Woodbine Ave. to Dixon St., across Kingston Rd. to Edgewood, to Hemlock, to Maughan Cres., to Ashbridge, to Applegrove, to Wilton Ave. extension, and along Wilton Ave. to Sackville St. This main will connect with the 12-in. main on Coxwell Ave., the 12-in. main on Leslie St., the 12-in. main on Carlaw Ave., the 12-in. main on Broadview Ave., the 24-in. main on Sumach St., and the proposed 42-in. main on Sackville St.

4. The fourth 42-in. main will run along the same streets as the third, to Maughan Cres. It will then run south to Orchard Park Rd., across Queen St., through a corner of the Ontario Jockey Club grounds to Eastern Ave., and along this street to Cherry St., thence to Front St., to Wellington St., to Simcoe St. This main will connect with the 12-in. main on Kingston Rd., the 12-in. main on Leslie St., the 12-in. main on Carlaw Ave., the 12-in. main on Broadview Ave., the 24-in. main on Sumach St., the proposed 42-in. main at Sackville St.,

An examination of the report of the Commission indicates that they contemplated only one supply main, and that through the northern section of the city a considerable distance removed from the point at which maximum consumption occurs. Therefore, even if their scheme were workable, it would be necessary for the municipality still to spend upwards of $2,000,000 upon a distribution scheme within the city limits, and $250,000 for additions and steam reserve at the high level pumping station.

In this project, in addition to the supply feature, provision is made for 32 miles of large distributing mains, at a cost of approximately $2,393,000. This will provide an almost ideal system of distribution, covering the needs of the city for many years to come.

Estimated Cost of Project as Recommended.

Lake crib complete and placed...	$ 400,000 00
Lake shaft, tunnel, and shore shaft...........	800,000 00
Site and buildings	500,000 00
Pumping equipment	380,000 00
Boilers and stokers	80,000 00
Coal and ash handling machinery............	30,000 00

Tracks and overhead equipment from York to pumping station	35,000 00
Motor and equipment for handling cars	5,000 00
Electric lighting unit at station	2,000 00
Twenty-six miles of distribution mains	2,040,000 00
Specials and valves	60,000 00
Filtration plant	600,000 00
Levelling, grading, etc.	5,000 00
	$4,937,000 00
Add 10% for engineering and contingencies	493,700 00
	$5,430,700 00
Six miles of distribution main—High Level pumping station to West Toronto, for part of which contracts have been awarded	353,000 00
Additions to High Level pumping station, and provision of steam reserve sufficient for ultimate output of this station, for part of which contracts have been awarded	250,000 00
Total	$6,033,700 00

Recapitulation.

Expenditure authorized by ratepayers (January 1st, 1913)	$6,677,000 00
Estimated cost of project as proposed	6,033,700 00
Balance to meet debenture discount and financing	$ 643,300 00

Outstanding Features of the Report.—Claiming that Lake Ontario is the only natural source of water supply for Toronto, the report passes the following observations upon the 3 possible locations for the new installation, which are:—

1. At Toronto Island adjacent to the present system.

2. At some point west of the present works, e.g., west of Humber Bay.

3. At some point east of the Island, which would mean at least as far east as the Woodbine.

The Island Location.—Site: Bed of lake slopes gradually for 1,700 ft. from shore to depth of 23 ft.; then falls with grade of over 10%, making problem of construction of intake difficult and uncertain.

Reliability: Essential that extension be placed at some distance from present system, else the same local cause might readily affect both.

Purity: Quite possible to treat present supply so as to make it perfectly safe and very desirable.

Distribution: Rapid expansion of city demands additional distribution centres conveniently situated for economy. Distribution from single source imprudent.

Western Location.—Site: Not fully investigated.

Reliability: No definite opinion advanced. Indications favorable.

Purity: Water around Humber Bay and to the west, polluted.

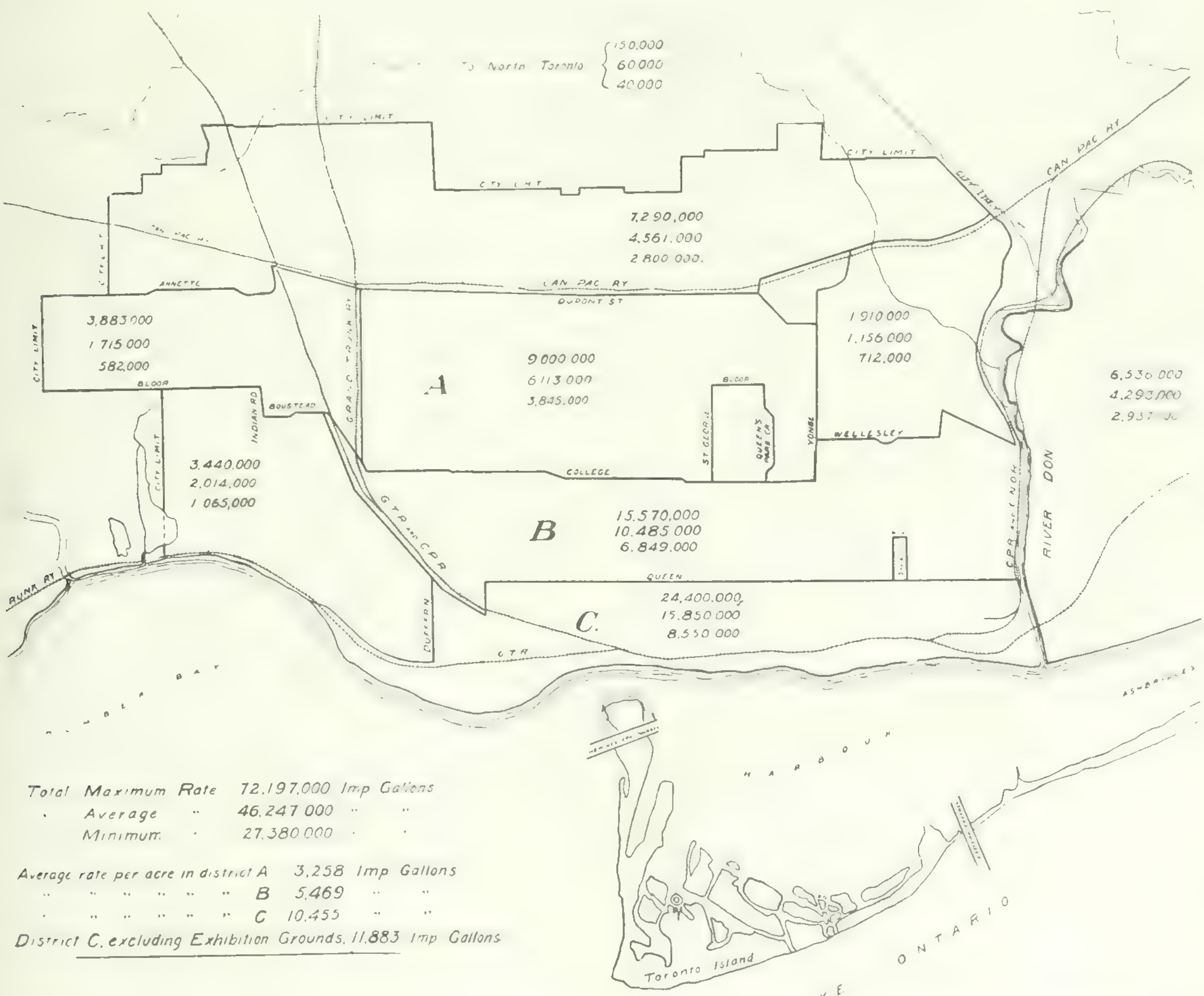

Fig. 4.—Maximum, Average and Minimum Daily Water Consumption of Toronto, as Determined by Pitometer Survey.

Distribution: Serious objection, in that heavy piping expenditure would be entailed.

Eastern Location.—Site: Effluent from Morley Ave. sewage disposal plant necessitates a location to the east. No advantage in site east of Victoria Park.

Reliability: Borings indicate feasibility of driving tunnel in good shale at favorable depth; also splendid location for intake. (See Fig. 2). Victoria Park "an almost ideal location."

Purity: Water from a point one mile from shore (2½ miles from Morley Ave. outlet) and 40 ft. below lake level, quite satisfactory, with after treatment; and fully as desirable as that taken from further east. Vastly superior to the present supply as regards turbidity.

Distribution: Admirable position for connection to present system. Distribution begins immediately upon leaving plant.

The report supports the choice of Victoria Park as the site for the proposed plant on the ground that it is most favorable from a distribution standpoint. The extensions can work in harmony with the present John St. station, constituting as well a duplication to serve the entire city in the event of interruption of the present plant. As the city expands eastward it will be logically situated for distribution. The supply there is comparable in quality with that of Scarboro' Heights, and 4½ miles nearer the city. The lake bottom is admirably suited for tunnelling and a crib may be conveniently located at a reasonable depth. A bar or ledge about a mile wide runs out from shore on an easy gradient, and at one mile out has reached a depth of 50 ft. Borings revealed suitable shale at this point 82 ft. below the lake level, this formation extending to the shore on a grade approximately paralleling lake bottom.

Pitometer Survey.—An interesting feature of the report is the result of an investigation by pitometer survey into the city consumption, as indicated in Fig. 4. The area of Toronto, excluding the Island, Harbor, Ashbridge's marsh lands, Humber Bay, and that portion of the Lake west of the Island, within the city limits, approximates 29.6 sq. mi., or 18,949 acres. From the plan the average consumption per day over this section of the city, within the period covered by the compilation, averaged 46,247,000 Imp. gal. An examination shows that in Districts "B" and "C" the average daily consumption amounts to 26,335,000 Imp. gal., or 56.9% of the total water supplied, or, in other words, 56.9% of the total water supplied per day, is consumed in 3,433.19 acres, which constitutes 18.1 per cent. of the entire acreage of the city. These figures show that the maximum usage is in the business and manufacturing section of the city, and that special distribution service must be provided in order to convey the requisite quantity of water at adequate pressure to the maximum user.

RAILWAY EXTENSION IN SOUTH AFRICA.

Amongst the larger projects which the South African Railway administration has on hand at the present time is an important deviation of the existing line between Maritzburg and Rietspruit, about 70 miles from Johannesburg on the main line from Durban. This alteration, which is known as the Town-hill deviation, has been contemplated for many years, its object being to reduce the heaviest gradient on the line, which is as much as 1 in 30. It will extend to about 12 miles in a country which is exceptionally heavy, and the work is so great that the department has decided to divide it up into several sections.

STEEL HARDENING AND TEMPERING.

THE hardening of steel has been thoroughly studied by metallurgists, who have given a great deal of time and thought to their investigations with a view to establish a satisfactory theory to account for this very marked phenomenon in connection with steel. The theories brought forth are both numerous and varied. Mr. R. B. Hodgson, of the Crooks-Roberts Company, Sheffield, recently read a paper before a meeting of the Institute of Mechanical Engineers of Great Britain, containing some interesting and practical notes on the hardening process. The following is abstracted from his paper:

In connection with the heat treatment of steel, microscopical evidence has proved most valuable, and it is believed that if two samples of carbon steel selected from two different and distinct sources, but each giving approximately the same chemical analysis, be prepared for microscopical examination under normal conditions, their appearance will be practically the same.

In reviewing carbon steel we find that an increase in the percentage of carbon is attended with increased hardness. In these days, however, we cannot base the definition of steel entirely on the peculiarity due to carbon, since there are other elements that can confer hardness to the iron. Iron readily alloys with different metals, such as aluminium, chromium, molybdenum, manganese, nickel, palladium, platinum, thodium, titanium, tungsten, uranium, vanadium, and many very important and remarkable results are obtained from the resulting alloys. The only metals that we need consider for our purpose are chromium, manganese, and tungsten since alloy steels containing these three metals lend themselves to, and are particularly suitable for cutting tools, which have to deal with work under conditions such that require the tool to be not only harder than can be expected in the case of ordinary carbon steels, but also capable of greater endurance under the two special circumstances of modern increased speeds, or to deal with the machining of very hard materials.

Chromium is used extensively in the production of special steels, as armourplates, axles, projectiles, and tool steels. The chrome iron-ores as found in either Asia Minor, Bohemia, France, Norway, North America, Silesia, and Shetland Isles, are the sources from which the alloy of iron with chromium is obtained. Ferro-chromium is prepared as a commercial article in a variety of grades, having different percentages of carbon and chromium. A grade specially valuable and used in the manufacture of high-class tool steel is 0.5 to 1 per cent. carbon, and 65 to 70 per cent. chromium. In the finished tool steel, such as very hard turning tools, the quantity of chromium varies between 2 and 3 per cent.

All steel contains some manganese, although the narrow limits of its contents, 0.2 to 1 per cent., as usually present in ordinary finished commercial carbon steels, does not materially influence the properties of the steel. Manganese frequently occurs in iron-ores and is partially reduced along with the iron, 5 to 20 per cent. Manganese will result in the production of a white pig-iron in a highly crystalline condition, containing a large amount of carbon in chemical combination, this is called "spiegeleisen," on account of the beautiful bright appearance of its crystalline plates, a condition which disappears if the manganese is increased above 20 per cent.

An alloy used extensively in steel making is that known as ferro-manganese, containing from 75 to 87 per

cent. manganese alloyed with steel. Manganese produces a material that is hard, tough, strong, and non-magnetic, and gives varying results according to the percentage. If 1 to 3 per cent. manganese be present the steel is brittle and unworkable, and up to 7.5 per cent. the steel may be likened to glass for brittleness, and beyond 7.5 per cent. the extreme hardness begins to disappear, but all manganese alloys possess extraordinary qualities of hardness combined with toughness, such as do not occur in the case of any other alloy. Manganese steels are so hard that they cannot be machined, but may be forged into various shapes as easily as very mild steel, and the ordinary process of quenching in water toughens but does not harden manganese steel. Sudden quenching at a high heat will improve the tensile strength and elongation.

Tungsten is chiefly prepared from wolframore, and the metal readily alloys with iron to form ferro-tungsten. When alloyed with carbon steels tungsten plays an important part in helping to confer great hardness upon the steel, but in the absence of carbon, the presence of tungsten will have very small influence on the physical properties of the steel. Further, whilst tungsten has practically no appreciable effect on the magnetic properties in low carbon steels, it is of great value in high carbon steel, since by its coercive-power with regard to magnetism it greatly increases the power of the steel to retain the magnetism, consequently tungsten is an important metal in connection with special magnet steels, and a high percentage will improve the magnetic properties of the steel very considerably. The composition of the steel used for permanent magnets is somewhat similar to a special tool-steel, but as a magnet steel is not required for cutting purposes, its composition is arranged so as to make most effective its properties of retaining magnetism.

The addition of tungsten will impart a fine-grained structure to a carbon steel, and the fracture of a tool steel containing about 1.3 per cent. carbon and 3 per cent. tungsten may be likened to a mole's back, so fine and velvety is the grain.

Self-hardening steels are alloys of iron, carbon, tungsten, and manganese, and in some instances chromium and other metals are added to bring about certain improvements in the qualities of the steel. These steels are called self-hardening, because if they are heated to a temperature of about 1,200 deg. C. (nearly a welding heat) and allowed to cool in the air, they become very hard.

The hardening and tempering of a piece of steel is an operation which, to the casual observer, may appear a very simple one, but it is undoubtedly one of the most delicate operations in connection with mechanical art.

The quantity and variety of tools and other steel articles that are handled in the Midlands, are so numerous that it is hardly possible to give a detailed description of the rules and methods for forging, hardening and tempering that can be applicable to the whole.

There are certain fundamental laws and principles relating to these matters, and if these are duly and properly observed, and correct methods adopted, they will invariably lead to satisfactory results. In my book, "Machines and Tools Employed in the Working of Sheet Metals," which was published in 1903, I mentioned how necessary it is to exercise special care in heating a tool to the required temperature before plunging it into the cooling bath for quenching, the principal points of importance to remember being gradual and uniform heating, and the quenching to be done in a plentiful supply of fresh clean water and brine, or rain water and brine.

A steel high in carbon will harden at a low heat as compared to the temperature necessary for a steel containing a low percentage of carbon, which fact makes it essential for the workman to have some knowledge as to the carbon content of the steel he is handling; also, he should at least have an approximate idea as to the correct temperature to which the steel had best be heated. What an important item the latter is—will be seen when we come to consider the actual application of the recalescence curve for fixing the correct hardening temperature.

At all stages in its manipulation, steel should be thoroughly and uniformly heated; that is, in the forge and rolling mill, in the smith's shop, as well as in the hardening and tempering shop, for if a piece of steel is hotter in one part than another, the expansion is necessarily variable, consequently contraction in hardening will also vary, there being higher tension in one part than another, resulting in either a warped or cracked tool.

In the forge, irregular heating means irregularity in forging, consequently inequality of tension in the article when in the rough forged state. But a reasonable amount of care on the part of a blacksmith will prevent trouble from this cause.

The difficulties of uniformly heating a piece of steel in an ordinary blacksmith's fire, or in a coal-fired furnace, are far too well known to need much comment from me. In the case of the coal-fired muffle, by exercising a certain amount of care, by occasionally turning round the steel, and by using a pyrometer in the muffle, it is possible to partly overcome the difficulties, but at all times experience and good judgment is necessary. Probably the next best way to ensure a regular heating is to use a gas-fired muffle or furnace, which can be readily arranged to maintain an even and correct temperature by adjusting the gas supply, and in this way considerably reduce the risk of burning the steel; and should a workman be unable to remove a tool immediately it is ready for quenching, the application of a pyrometer will guide him and so prevent disaster. An incidental advantage of the gas-fired furnace is the increased cleanliness, due to the freedom from smoke and dust, which are inseparable where the ordinary blacksmith's fire or coal-fired muffles are employed.

The International Marine Signal Company, Limited, of Ottawa, have closed their shop, and it is rumored in Ottawa that the company has been purchased by Mackenzie, Mann & Company. When a representative of *The Canadian Engineer* called at the company's office in Ottawa last Friday, an official of the company would neither confirm nor deny this rumor, but stated that Mr. Thomas L. Willson, the former president of the company, has resigned from the Board of Directors, and that Mr. Lewis Lukes, of Mackenzie, Mann & Company, Toronto, had been elected president of a new Board of Directors, which would have their headquarters at Toronto. When interviewed this week at Toronto, Mr. Lukes stated that he was not yet in a position to discuss the matter, and that he would be unable to give out a statement for a few days as to just how the affairs of the company would be arranged for the future.

COAST TO COAST.

Port Arthur, Ont.—A new telegraph line has been completed which now affords direct communication between Port Arthur and Toronto. In its construction over 800 miles of copper wire were used.

Winnipeg, Man.—The earnings of the Winnipeg Electric Railway on actual street car operation in the city of Winnipeg for 1913, were $2,384,597.28, an increase of $269,604.48 over the earnings of 1912.

Winnipeg, Man.—The financial statement issued by the provincial department of public works shows Manitoba's Government elevator system to have had a surplus of revenue over expenditures to the extent of $329.84 for the year ending November 30th, 1913. Receipts totalled $58,770.71, and expenditures, $58,440.87.

Weston, Ont.—A recent improvement has been effected at Weston by the Water, Power, and Light Commission in its endeavor to make Weston the best lighted village in York County, Ont. Every pole on each side of the business section of Main Street now bears a heavy-powered light; and on the east side, the lamps are encased in large frosted globes.

Winnipeg, Man.—The report of the public utilities commission shows the condensed earnings of the Manitoba Government telephones for the twelve months ending November 30th to have been as follows: revenue, $1,707,149.74; expenses, $1,269,909.90; and net earnings, $437,239.84. The interest charges for the year were $406,975.20, leaving a surplus of $30,264.64.

Ottawa, Ont.—Some of the improvements at Ottawa effected by the civic council of 1913 are the following: the provision of a good temporary water supply in the form of 11 artesian wells; a reduction in the Municipal Electric Commission's rates; the prevention of increased street railway rates; a civic financial surplus; and a greater mileage in the construction of granolithic walks and pavements than has been accomplished in any previous year.

Toronto, Ont.—The definite announcement has been made by Sir William Mackenzie, president of the Canadian Northern Railway, that September 1st next, will see the completion of the C.N.R. transcontinental from Quebec through to the Pacific Coast; and the early fall, the operation of a passenger service that will require an equipment for the operation of 15 trains each way daily. He states, also, that $50,000,000 were expended last year in construction upon this continental line.

South Vancouver, B.C.—Mr. H. B. A. Vogel, secretary of the North Fraser harbor commission, stated, while addressing municipal ratepayers recently, that progress is being made by the commission. Harbor commissioners in the United States and European countries have been requested for information, and the appointment of a competent engineer is to be made shortly. Until the engineer shall have examined the specifications of the contract, the Dominion government is holding up the jetty and dredging project for the mouth of the North Arm and a distance of five miles inward.

Montreal, Que.—Comprehensive schemes of extension, improvement and double-tracking formed the basis of procedure by the C.P.R. in 1913; but the present year will have to be devoted to the completion of these schemes, rather than to the projection of any extensive new program. Thus, the expenditures estimated for the western appropriations of 1914 are almost entirely confined for the present to the completion of track-laying, etc., on grades already built, on branch lines, extensions and double-tracking, the latter of which will eventually connect Winnipeg to Vancouver; and to the building of the Rogers' Pass tunnel.

Victoria, B.C.—Of the E. & N. Railway company's new line on the east coast from McBride Junction to Courtenay, a stretch of 45 miles, 15 miles have been completed; and when the bridge being erected over the Big Qualicum river is finished, steel work and ballasting will be continued over another 15 miles, upon which grading is complete, and should be concluded by the middle of next April. The road will then have reached the Sable River, in the vicinity of Baynes Sound, where another steel viaduct will be erected, material for which is already on hand. It is estimated that the road will reach Union Bay in May; and on the 10 miles between that point and Courtenay, the Trent river must be spanned. This is not expected to delay the completion of the entire road beyond next July.

Winnipeg, Man.—Since January 1st, 1913, the C.P.R. has completed the largest construction programme ever undertaken by this company on lines west of the lakes in any one year. Eight hundred and fourteen miles of grade have been constructed, 753 miles of steel laid, and 878 miles ballasted, making a grand total of 2,472 miles of additional trackage either completed or partly done. Besides this new construction the new yards in Transcona, with 100 miles of track, have been completed, the new double-track bridge connected over the Red River, and 4,000,000 bushels of capacity have been added to the elevator at Fort William. Besides progress in double tracking the company has made considerable headway with the Weyburn-Lethbridge line, the Swift Current-Bassano line, and the 5-mile tunnel under the Selkirks, which will be completed in three years. Double tracking west of the lakes now totals 860 miles.

Montreal, Que.—A large annex has just been completed to Windmill Point Elevator at Montreal. The main elevator, which was completed and put into operation in the spring of 1906, has a capacity of 1,080,000 bushels. The capacity of the annex is 1,070,000 bushels, which makes a net accommodation of 2,150,000 bushels. There are in the new building 28 concrete tanks, 25 feet in diameter and 100 feet in height, arranged at right angles in four rows, with seven tanks in each row. The tanks are constructed of reinforced concrete, having their adjacent sides rigidly united so that the four-pointed, star-shaped spaces between the circular tanks may be used for storage as well as the circular tanks themselves. The large tanks hold approximately 33,000 bushels apiece, and the star-shaped or interstice bins hold approximately 8,000 bushels each. On the Grand Trunk system, the Windmill Point Elevator is now second only in size to the 5,700,000-bushel elevator situated at Fort William.

St. Catharines, Ont.—The city engineering department has had an exceptionally busy year in 1913, so much so that a second assistant has been required by City Engineer Near for clerical work. Mr. Near, moreover, has undertaken to improve the system of the office department so as to satisfy more fully the requirements of the Legal Department of the Court of Revision in connection with the Local Improvement Act. To this end, he has introduced a card index system giving the history of each local improvement from its recommendation to its completion. Another improvement instituted is printed certificate forms for all payments, giving the required information as to by-laws for the City Treasurer. A third is a file and index to all contracts, by-laws, and agreements. A retention book has also been introduced, giving readily the date when final inspection of such work shall be made to release the guarantee drawbacks. Finally, a system of filing and indexing all plans of sub-divisions, local improvements, etc., is gradually being perfected.

Vancouver, B.C.—The work completed by the B.C.E.R. Company during the past year, shows a total of 9⅝ miles of new track. Other large works outside of the city, constructed during the year include the logging railway from Port Moody to Coquitlam dam; and on Vancouver Island, the

Saanich line extending 22 miles from Victoria to Deep Bay. Work on the construction of Coquitlam dam, which has been in progress since 1908, has been ended and the Jordan River dam on Vancouver Island has also been finished, both works which have cost millions of dollars. The Kitsilano car barns have been erected since the opening of the year; new car barns were added to those already in existence at New Westminster; and the facilities for handling cars have also been greatly improved there by the building of a large interurban freight yard. The No. 2 power house on the North Arm has been fully completed and when fully equipped will have a capacity of 42,000 horsepower. One unit of 14,000 is already practically installed. Work is started, although not finished, on the new power-receiving station in the District Lot 118, Burnaby, and on the building of an extension to the Jordan River power house on Vancouver Island that will double its capacity.

Vancouver, B.C.—It has been announced by Mr. Cameron of the Pacific Dredging Company that of the 4,000,000 cubic feet of material which will have to be removed to make the waterway navigable and provide a turning basin for large ships, 800,000 cubic feet have been already transferred to the site of the Canadian Northern Pacific terminals on the other side of the Main Street bridge. A dipper dredge is being installed to supplement the operations of the hydraulic suction plant; and it is now expected to remove twice the amount of material each day. The hydraulic dredge is working in the narrow arm of the creek adjoining the G.N.R. station. The dipper apparatus will commence operations near the Connaught bridge. The pipe lines from the suction dredge were concentrated for some time on a big hole, 1,000 feet by 1,000 feet, immediately east of the bridge. This had to be filled before any appreciable difference was made on the large area to be reclaimed. The dirt deposited in the creek extends over an area of eighty acres, and already a fair-sized island has been formed east of the bridge. A temporary barrier has been constructed across the creek near the bridge to prevent the material from seeping back into the main portion of the waterway.

Toronto, Ont.—Another discovery of natural gas in Toronto, though not of a pressure to foretell any commercial value, was made while boring operations for a pure water supply were being carried on beneath the new Dominion Bank Building, corner King and Yonge Streets. Indications of a high pressure were at first reported, but they have been discredited by the statements of Dr. A. P. Coleman, Professor of Geology at the University of Toronto, and of Mr. G. G. Grist, General Manager of the Canadian Stewart Company, which is erecting the building. Dr. Coleman stated that, though a gas flow of 700-pounds pressure as had been reported was not impossible, yet the result of numerous boring tests made in Toronto had shown the gas flow found to be very weak. Mr. Grist claims that the vein of gas discovered under the Dominion Bank Building was small and of little consequence. The boring for water had attained a depth of over 1,100 ft., when indications of gas in the shaft caused a cessation of operations, through fear of tapping a voluminous flow at high pressure. The shaft was hurriedly filled with concrete, to a depth of about 300 ft., and thereby a stop was put to the endeavor of the builders to provide the building in this way with a water supply that would obviate the use of the present city supply, and its deleterious effect upon valves, pipes, etc.

Revelstoke, B.C.—Mr. J. P. Forde, district engineer of the public works department, Revelstoke, says in connection with the Columbia river survey, concerning which inaccurate statements have recently been published, that two parties are engaged in the work, and have been in the field for the past two summers. These are in charge of Mr. W. F. Richardson and Mr. H. F. Muerling. While they have not yet completed their work, it is expected that they will do so within a few weeks, and make their report to the Minister of Public Works on the engineering features of the work of making this river a western wheat route to Portland. The report of the minister will not be complete until the economic features of the scheme have been considered. During the season of 1912-13, Mr. Richardson's party was engaged in surveying the river between Golden and Revelstoke, and the report on this work has already been sent to Ottawa; and during the season of 1913-14, that party has been engaged on surveys between Revelstoke and Waneta on the international boundary, and is still engaged on those surveys. The work being carried on under Mr. Muerling has been confined to special surveys in the vicinity of Burton, which is at the lower end of the Columbia river narrows, connecting the Lower and Upper Arrow Lakes. These surveys are being made with the view of improving navigation at the narrows, where improvements will be required in the immediate future, even if the larger scheme of making the river navigable to the Pacific coast should not be put in process. The reports of the field engineers are expected to be complete some time in March; and the report covering both the engineering and economic aspects of the scheme will then be prepared by the Government engineer's department for the consideration of the minister of public works.

Montreal, Que.—Mr. A. S. Baxendale, managing director of the Universal Radio Syndicate, which is carrying out a contract to establish a wireless telegraphic service between Canada and the United Kingdom, while in Montreal, made the following interesting statements: "There will be in connection with the Newcastle installation 6 wooden towers, 300 feet high, and one of steel with a height of 500 feet, while the number of kilowatts will be 300. The San Francisco station, which connects with Honolulu, has but 100; and when it is considered that the range is about the same distance, about 2,000 miles, the power of the Canadian station and its possibilities for a superior service will be understood. The station on the other side of the Atlantic is at Bally Bunion, in County Perry, Ireland, and from there the company will have a line to London, which will be leased from the English post office department. It is expected that arrangements will be successfully completed with the C.P.R. to handle the land business of the Universal Radio Syndicate. Mr. Baxendale stated further that the contract with the Canadian Government calls for 80 words a minute, while the Newcastle and Bally Bunion system will be equal to at least 150 words a minute. He stated also that the United States government in a piece of test work had been most successful at a range of 3,000 miles from the Arlington station, near Washington, and that with only 30 kilowatts and mostly at night. Consequently, one can easily measure the possibilities of the Canadian system. In arranging for 300 kilowatts, the company are looking for the very highest rate of speed yet obtainable. Experimental tests will be commenced at Newcastle in February; but it will probably be early spring before the line is opened for regular transoceanic business.

PERSONAL.

J. LANNING, B.A.Sc., has been appointed superintendent of the sintering plant of the Mond Nickel Company, in their smelter works at Coniston, Ont.

C. KRUMBIEGEL, resident engineer of the Deutsche Maschinenfabrik A.G., has returned from Germany and joined the staff of the company's Canadian agents, Messrs. Gerald Lomer, Limited, Montreal.

JAMES COWIN, formerly Winnipeg manager of C. A. P. Turner's office, and E. F. FEE, of Winnipeg, have formed

a partnership and will make a specialty of reinforcing steel. Their office is at 701 Canada Building, Winnipeg.

J. STOKES, of the firm of Ashmore, Benson, Pease & Company, Limited, Stockton-on-Tees, England, called at *The Canadian Engineer* office last week on his way to England after having spent several weeks in Canada.

HAROLD C. STEVENS, principal assistant engineer to JOHNSON & FULLER, consulting engineers and sanitary experts, New York City, has been admitted to membership in the firm, the other members being George A. Johnson and William B. Fuller.

H. B. TAYLOR, M. Am. Soc. M.E., read a paper, illustrated by slides, on "The Present Practice in Design and Construction of Hydraulic Turbines" before the Montreal mechanical section of the Canadian Society of Civil Engineers on January 15th.

B. E. T. ELLIS, whose article on the West End sewage disposal works at Hamilton, appears elsewhere in this issue, and STANLEY M. OBORN, Toronto, have formed a partnership as consulting and civil engineers, specializing in main drainage works of all kinds, with two offices, one in Toronto, in charge of Mr. Oborn, and one at 158 Cumberland Street, Hamilton, under Mr. Ellis' supervision.

B. E. T. Ellis, C.E.

Mr. Ellis has had 14 years' experience in municipal engineering, in Canada and England, chiefly main drainage work, but including roads, bridges, street railways, sewers, etc. Besides designing the East and West End disposal works, on the 2-story sedimentation tank principle, in Hamilton, he has prepared plans and estimates for the East End main drainage scheme (combined system) for that city, as well as for the new storm-overflow sewer to relieve the existing sanitary sewers in the central part of the city.

Previous to specializing in main drainage work Mr Ellis has acquired a thorough training in the city engineering departments of West Bromwich, Birmingham, and York, England; and of Toronto and Hamilton, Canada. For three years he was an assistant to Mr. Albert D. Greaterox, M. Inst. C.E., a past-president of the Institution of Municipal and County Engineers.

F. C. GAMBLE, one of the vice-presidents of the Canadian Society of Civil Engineers, and chairman of the Victoria branch of the Society, gave an illustrated lecture to that branch recently on engineering work in British Columbia during the past half century.

W. A. McLEAN, Provincial Highway Engineer for Ontario, was in Nova Scotia last week, where he gave two addresses at the Provincial Agricultural College, Truro. One was based upon the principles of road organization, and the second dealt with road construction in Ontario.

WILLIAM H. CONNELL, Assoc. M. Am. Soc. C.E., chief of the Bureau of Highways and Street Cleaning, Philadelphia, Pa., on January 15th delivered an illustrated lecture on "Organization and Methods of Street Cleaning Departments" before the Graduate Students in Highway Engineering at Columbia University.

S. WOLFF, formerly manager of the Cleveland office of the Allis-Chalmers Manufacturing Company, has been appointed Chicago manager for the DeLaval Steam Turbine Company, manufacturers of steam turbines, centrifugal pumps, centrifugal air compressors, speed-reducing gears, etc., with offices in the Peoples' Gas Building.

C. H. RUST, C.E., of Victoria, B.C., is spending a few weeks in Eastern Canada and New York. Last week he attended the annual meeting of the American Society of Civil Engineers, of which he is vice-president, and next week he will attend the annual meeting of the Canadian Society of Civil Engineers, of which he is a past president.

G. R. B. ELLIOTT, of Vancouver, has been awarded the prize for the best paper read before the Pacific North West Society of Engineers during the year 1913. His subject was "The Fraser River Delta." The membership of the organization extends from San Francisco north, the headquarters being in Seattle. Mr. Elliott who is the first Canadian to secure the annual award, is believed to have won it largely because of the volume of original information on the subject contained in his article.

EDMONTON'S NEW COMMISSIONERS.

The City Council of Edmonton has dismissed the entire city commission board, composed of A. G. Harrison, A. J. McLean, and John Chalmers, and has appointed commissioners, each with specific duties. M. S. Booth was chosen commissioner of health and safety, and Bryce J. Saunders, commissioner of public works. John Chalmers was re-appointed and given charge of operation.

COMING MEETINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual meeting will be held in Montreal, Que., January 27-29, 1914. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal, Que.

CANADIAN CLAY PRODUCTS MANUFACTURERS' ASSOCIATION.—Annual Convention to be held at King Edward Hotel, Toronto, Jan. 27th, 28th, 29th, 30th. Secretary, J. R. Walsh, 40 Blake Street, Toronto.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th, 1914. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.—Annual Meeting to be held in New York, January 21st to 23rd, 1914. Secretary, E. A. Scott, 29 W. 39th Street, New York City.

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A weekly paper for engineers and engineering-contractors

THE McKELLAR RIVER BRIDGE AT FORT WILLIAM

PARTICULARS OF THE NEW SCHERZER ROLLING LIFT BRIDGE RECENTLY COMPLETED FOR THE CANADIAN PACIFIC RAILWAY COMPANY —PROVIDES ACCESS TO NEW TERMINAL YARDS ON ISLAND NO. 1

IN our issue of October 2nd a description was given of the new electrically operated Strauss trunnion bascule bridge, the largest double-deck, double-track bridge of the bascule type in the world, which was built for the Canadian Pacific Railway Company in connection with the new terminal system at Fort William, Ontario. The yards and loading docks which the company are developing on Island No. 1, can only be conveniently reached by bridges over the Kaministiquia and McKellar Rivers. These, being both navigable rivers, require the bridges to be of the bascule type. The article referred to above relates to that over the Kaministiquia, while the following is a description of that over the McKellar. This is a single-leaf, four-track, Scherzer rolling lift bridge. This span is 120 ft. to the centre of supports, giving a clear channel of 114 ft., while the track for the segmental girder is 32 ft. long. Two of the tracks are for the railway, while the other two are for electric cars. There are three trusses 31 ft. 6 in. c. to c. and 31 ft. 6 in. deep. The segmental girders have a radius of 25 ft., and when the bridge is rolling or opening, they travel approximately 30 ft.

There are two operating motors, not fixed on the stationary part of the bridge, but moving with the bridge as it opens. The motors are connected by gearing to pinions which mesh with racks on the rack girder, which is stationary.

When the bridge opens, it merely rolls backward. In order to ensure this the segmental girders are meshed into the track girders by means of a form of gearing consisting of square projections about one inch high on the track girders, with corresponding recesses in the segmental girders.

The angle through which the bridge leaf moves between the closed and open positions is approximately 74 deg. No equalizing gear is interposed between the operating pinions and the motors to balance up the stress of each of the pinions, but two couplings have been provided on the main shaft which have to be drilled in the field after all the gears have been adjusted.

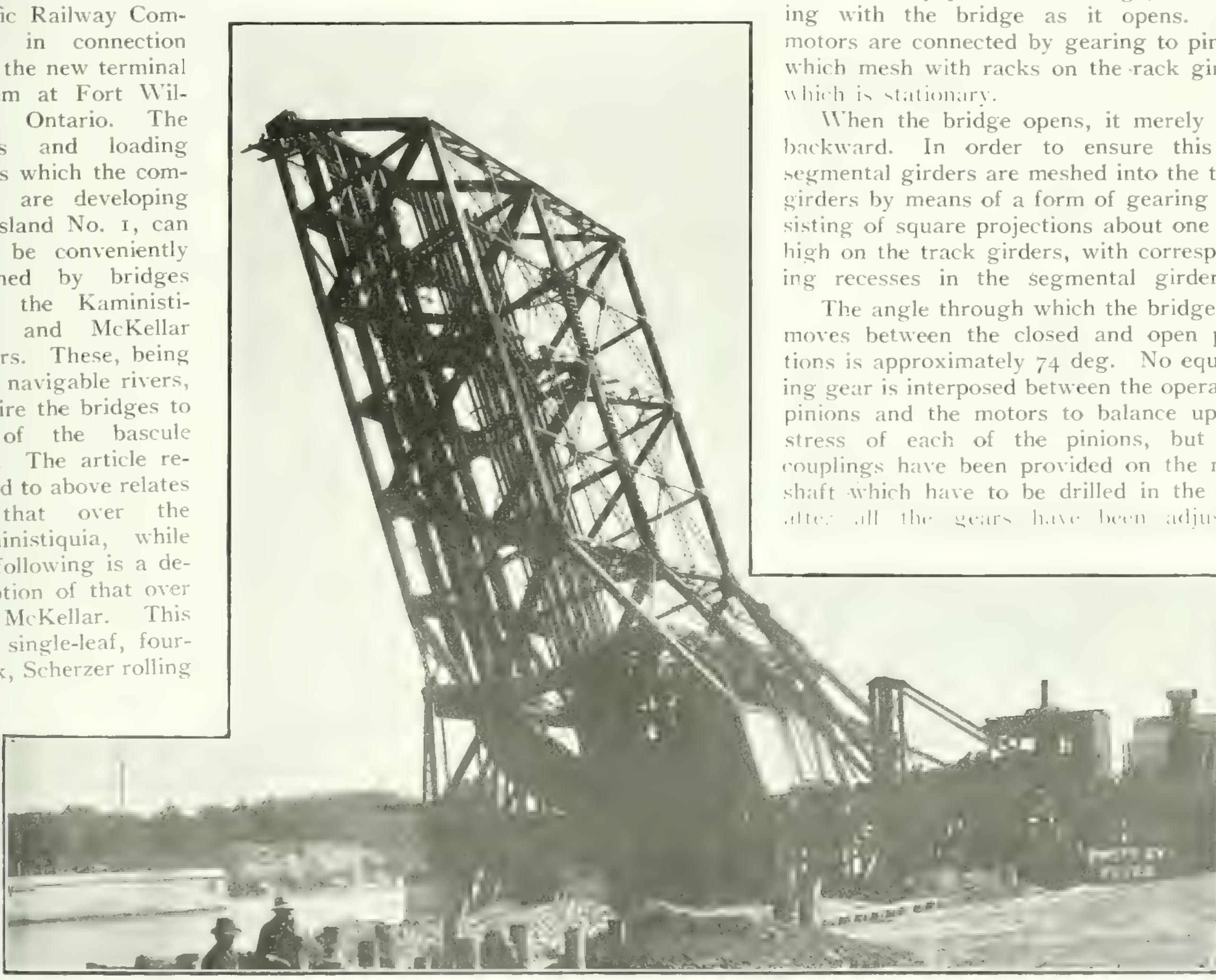

Fig. 1.—Bridge for the C.P.R. Over the McKellar River, Near Fort William, Ont.

Method of Operation.—There are two operating motors, 37-h.p., 680-r.p.m., 550-volt, 60-cycle, fitted with solenoid brakes. As the motors turn through approximately 74 deg. around an axis, parallel to the motor shafts, the bearings have been specially designed. For

the same reason it is not possible to fit the solenoid brakes in the usual manner on the end shield, but the solenoid brake has been turned through 45 deg. This arrangement prevents the solenoids beng in a horizontal position when the bridge is open. The solenoid brakes are provided with release attachment and automatic trip.

For the operating motors two controllers geared together have been used.

The two end locks are motor-operated by a 2-h.p., 1,200-r.p.m., 550-volt, 60-cycle motor. This motor is fitted with solenoid brake, and operates the end locks through worm gearing. The motor only operates in the horizontal position, but as it moves with the bridge, it has been necessary to provide it with special bearings. Provision was also made for operating the end locks by hand, by means of a lever in the operator's cabin. When the end locks have been withdrawn, they are held back by means of catches, and remain in that position during the whole time the bridge is raised. Provision is made for the catches to be knocked out by a stop as the bridge again reaches the nearly closed position. The position of the end locks is indicated in the operator's cabin by means of an indicating lamp, operated through a lock signal switch.

Emergency Brake.—The emergency brake is operated by means of a 3-h.p., 550-volt, 60-cycle motor, which is geared to a crank disc. A pin on this disc is connected to a lever, which releases the brake mechanism. The brake is normally set by a spring. There is a small solenoid brake on the motor which sets when current is applied, and releases when current is off, thus operating in the reverse manner to the usual solenoid brake. A drum type limit switch, mounted on top of the motor and driven by a sprocket chain from the back shaft of the motor, is used to make proper connections. The operation is as follows

Assuming the main brake is set to release the brake, the triple pole line switch on the emergency brake current is closed. The motor immediately starts and makes a few revolutions, bringing the crank disc pin to the upper position. When it reaches this point, the limit switch opens the motor circuit and at the same time energizes the solenoid, thus setting the brake on the motor. This holds the motor and prevents it from rotating backwards. So long as the solenoid brake is energized, the main brake is kept in release. To set the brake, the triple pole switch is opened. This de-energizes the solenoid, and releases the brake on the motor. The force of the spring on the main brake then immediately pulls around the crank disc and resets the brake.

Operation of the Motor and Interlocking System.—When the bridge is closed and ready for traffic, the arm of the lock signal switch and the arm of the bridge signal switch are in the position marked "closed" and the contactors in the circuits of the main operating motors and the lock are open. To open the bridge the first step required is to set the railroad signals at "danger." Until this is done, the lock motor contactors remain open and the end lock cannot be withdrawn. Until the end locks are withdrawn, the contactors of the operating motors remain open and these motors cannot therefore be started.

The action of moving the lever to set the railroad signals at "danger" closes the switch in the railway signal cabin. When this switch is closed, the contactor coils of the lock motors are energized and close the contactors. The circuit breaker is then closed, the controller handle of the lock moved around and the lock withdrawn. As the lock bar moves out it operates the lock signal switch, and this in turn changes the signal lights in the railway signal cabin from white to red, thus indicating that the bridge is

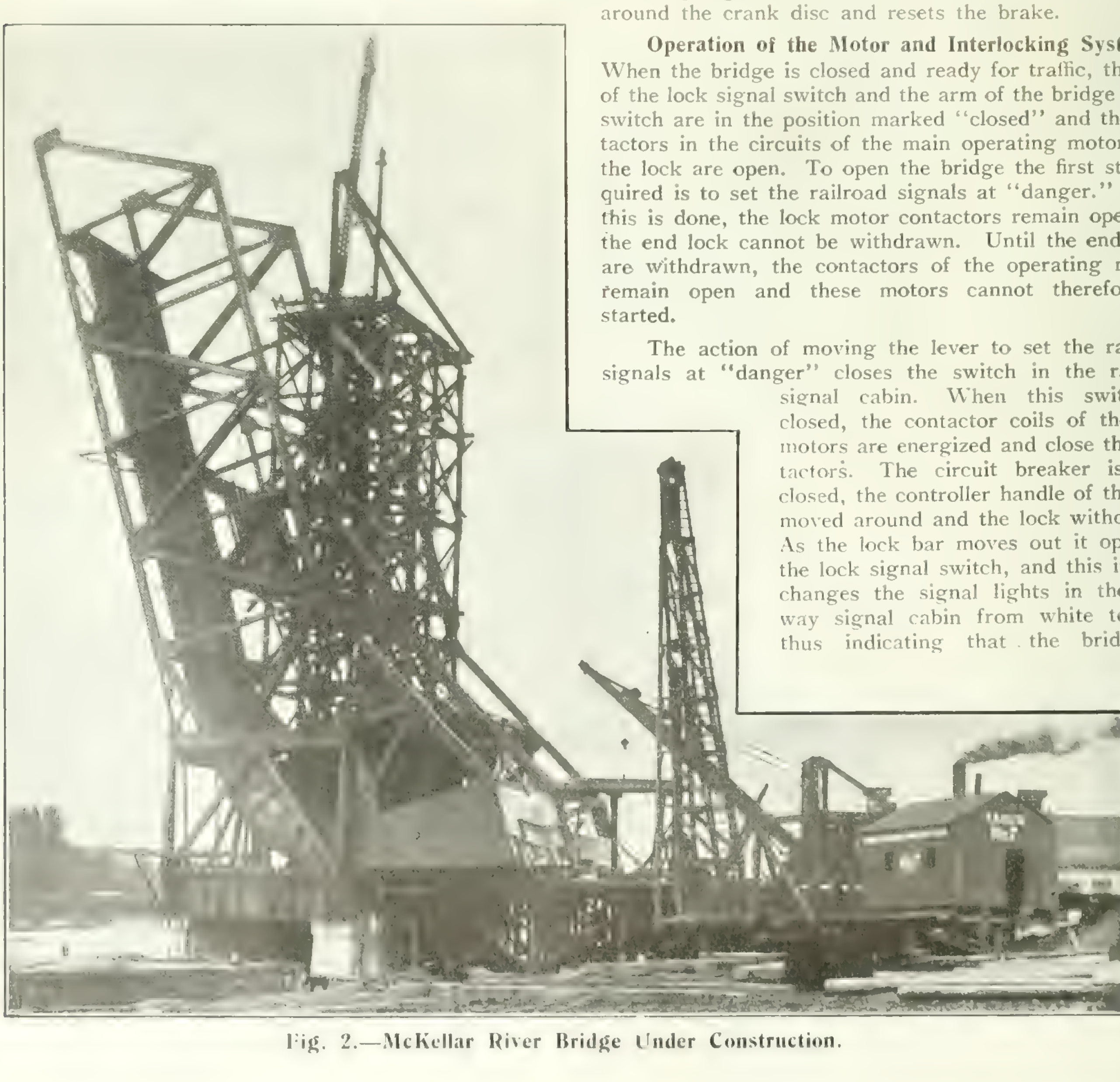

Fig. 2.—McKellar River Bridge Under Construction.

closed to traffic. A similar change in lights takes place on the bridge operator's signal lamp panel, the lights changing from "lock closed" to "lock open." At the same time the lock signal switch closes the circuit of the operating coils of the contactors in the circuit of the main operating motors.

As soon as the "lock open" signal light has shown up, the handle of the controller should be moved to the "off" position and the circuit breaker opened. If the controller handle is not thrown to the "off" position in time, the low voltage release coil of the circuit breaker will be short circuited through a set of contacts on the lock signal switch in series with a set of auxiliary contacts on the controller. It will be noticed that the circuit breaker of the lock motor must either be opened by hand or tripped automatically as above, before the oil switch for the main operating motors can be closed, for the auxiliary switch on the circuit breaker opens the circuit of the low voltage release coil on the oil switch when the circuit breaker is closed.

After closing the oil switch, the emergency brake is released by closing another switch. The main operating motors can then be started and the bridge raised by moving around the handle of the controllers. The first notch on these controllers releases the solenoid brakes only on the motors and this notch can be used at any time when it is desired to allow the bridge to coast. As soon as the bridge starts to open, the arm of the bridge signal switch moves from the position marked "closed" and thereby opens the contactors in the lock motor circuit. This prevents the end lock being operated while the bridge is open. As long as the bridge is closed the "fully closed" light (white) on the signal lamp panel shows up, but as soon as the end of the bridge lifts off of the pier, this light is extinguished. An auxiliary indicator switch mounted on the end of the moving leaf of the bridge was used for this light as it was found impossible to obtain a definite indication of the "closed" position of the bridge by means of the bridge signal switch operated by the movement of the bridge. The remaining lights, however, on the signal lamp panel, which show up in turn as the bridge opens, are operated from contacts on the bridge signal switch. The channel lights which change from red to green when the bridge opens are also operated from this switch. If the operator fails to throw the controller handle to the "off" position after the "nearly open" signal light has shown up, the low voltage release coil of the oil switch is short circuited by means of a set of contacts in the bridge signal switch in series with contacts in the controller. This arrangement trips the oil switch, cutting off current from the motors and setting the solenoid brakes. If through any cause switch mechanism should fail to operate and open the switch, an alarm bell, which is connected in place of the usual series resistance of the low voltage release coil, rings continuously until the operator throws the handle of the controller to the "off" position.

In closing the bridge the handle of the main controller is, of course, moved around in the reverse order. No automatic cut-off is used when closing the bridge as a set of air buffers are provided to prevent shock to the structure when the end of the bridge strikes the pier. If the bridge is traveling too fast, these air buffers will cause the motors to be overloaded and so trip the oil switch. The bridge can, if necessary, be held down on the pier by keeping the controller on the second or third notch until the emergency brake is set—thus holding the bridge in position. The controller handle is then moved to the "off" position and the oil switch is opened. The circuit breaker of the lock motor is then closed and the lock moved into place. In closing the lock, the circuit breaker will also be tripped out unless the controller handle is moved to the "off" position as soon as the "lock closed" signal light shows up. When the lock is closed all signal lights show up white, indicating that the bridge is safe for traffic. During those times when the bridge is closed and the locks in place, the lock motor circuit breaker is closed so that the auxiliary switch disconnects the alarm bell and low voltage release coil of the oil switch from the 110-volt busses. A set of emergency knife switches are provided on the switchboard panel, which, when closed, cut out the main motor and lock motor contactors respectively. These switches are normally sealed in the open position and would only be made use of in case of damage to any of the contactors or some other emergency condition requiring operation of the bridge independently of the interlocking system.

The bridge signals described above are interlocked with the railway company's interlocking system in such a way that a train would be derailed if it attempted to cross while the bridge was in the open position.

Erection and Details.—The bridge was erected in the open position by means of a stiff-leg derrick mounted on top of a wooden erection tower 125 ft. high. The pouring of the concrete for the counterweight was carried on simultaneously with the erection of the steel so as to balance the structure at all times during erection.

The current for operating this bridge is obtained from the Kaministiquia Power Company and is 2,200-volt, 3-phase, 60-cycle, A.C. current, stepped down to 550 volts for use on the bridge.

The electrical control apparatus is housed in an operator's house on one side of the bridge.

The bridge is also equipped with a hand operating mechanism for use in case of an emergency.

The total weight of the steel work and machinery is approximately 660 tons.

The bridge was designed by the Scherzer Rolling Lift Bridge Company, of Chicago, under the direction of Mr. P. B. Motley, engineer of bridges for the Canadian Pacific Railway Company.

The bridge was fabricated by the bridge department of the Canada Foundry Company in their Toronto works and all calculations in regard to counterweight, etc., were worked out in their engineering department after the shop drawings were made.

The entire electrical equipment was furnished and installed by the Canadian General Electric Company.

PROSPECTIVE C.P.R. DEVELOPMENT IN THE WEST IN 1914.

The Canadian Pacific Railway appropriations for Western Canada in 1914, are almost entirely confined to the laying of steel on over 600 miles of track now graded and waiting for it; to branch line extensions, and to the building of Rogers' Pass Tunnel. There will be a continuation of the double-track work, which was pushed so vigorously in 1913, and the close of the year will find great strides having been made toward connecting Winnipeg with Vancouver by a double track line.

The appropriations also provide for the completion of the terminals at Winnipeg, Calgary and Vancouver.

SOME FALLACIES IN CEMENT TESTING.

A DANGER that invades the testing of cement, in that it frequently leads to numerous unfounded complaints and disputes as to its quality, is the judgment expressed from results obtained by an inexperienced operator in carrying out such tests. These operations are no longer exclusively confined to the laboratory of the expert as they once were, and almost every user of cement in any considerable quantity either carries his own tests on the material, or delegates the work to one of his staff. W. L. Gadd, F.I.C., M.C.I., read a very interesting paper at a meeting of the Concrete Institute of Great Britain on December 11th, 1913. Although the address did not enlarge materially upon the recognition of cement testing as a highly specialized work requiring a skilful and extended knowledge of the properties and characteristics of the material, it was clearly pointed out that several fallacies appeared to underlie some of the recognized or suggested processes of testing. The author observed, at the same time, that the accuracy of the testing was necessarily so pronounced that the mere following of instructions given in a booklet or a specification would not suffice.

In the main, the paper dealt with the fallacies mentioned above, and the points in the British standard specifications which appeared open to criticism. The portion of his paper dealing with this phase of the subject is reproduced as follows:—

The standard specification stipulates that before any sample of cement is submitted to certain tests it "shall be spread out for a depth of 3 in. for twenty-four hours in a temperature of from 58 deg. to 64 deg. Fahr."

The object of this procedure appears to be twofold—i.e., (*a*) to cool the cement to the normal temperature of the atmosphere, and (*b*) to obtain conditions similar to those governing cement which has lain in sacks or casks for two or three weeks—i.e., during the possible period between shipment and use.

As regards (*a*), this can be very simply done without exposing the sample to air; as regards (*b*), the author has made experiments which show that there is no relation between the effects of aërating cement for twenty-four hours and storing in sacks for two weeks or a month; further, that the setting time is differently affected when the same cement is aërated or stored in bulk in different localities or at different periods. In some cases the effect of twenty-four hours' aëration is the opposite to that produced by storage, and storage or aëration at one period has an opposite effect to storage or aëration at another period. For instance, one sample aërated for twenty-four hours at the beginning of the month of July resulted in a quickening of both initial and final sets, whereas the same sample aërated for twenty-four hours in the same room a fortnight later resulted in the exactly opposite effect on setting time.

This appears to effectively dispose of the somewhat prevalent idea that changes in setting time are due to some inherent property of different cements. The erratic behavior found is common to all the samples tested, the composition of which varied within considerable limits, the lime contents, for instance, ranging from 64 to 59 per cent.

The retardation or acceleration of setting time on storage or aëration cannot, therefore, be due to peculiarities in the cements themselves, but must be due to chemical changes brought about by the absorption of some constituent present in the atmosphere.

Cement has a strong affinity for moisture in the first place, and for carbonic anhydride in the second place, and these constituents are present in the atmosphere in variable proportions at different times and in different localities.

From former experiments and reasoning I have held the opinion that absorption of moisture results in a retardation of setting time, while absorption of carbonic anhydride produces an accelerating effect. Cement exposed to both influences will therefore have its settling characteristics affected one way or the other according to the relative amounts of moisture and carbonic anhydride absorbed, the net effect being the resultant of the two opposing forces.

In order to test this theory I have made the following laboratory experiments, where the conditions can be under control and standardized, which is rarely possible in so-called "practical" tests.

A quantity of slow-setting cement (600 grammes) was placed in a large glass tube, which it half filled, and a current of purified air, freed from ammonia, carbonic anhydride and moisture, passed over it continuously for twenty-four hours. The total volume of air passed through the apparatus was about 173 litres.

The air was purified by being bubbled through dilute sulphuric acid (which served to measure the rate of flow as well as to remove any ammonia vapors), then drawn through a soda-lime tower to remove carbonic anhydride, and finally through a large calcium chloride U-tube to remove every trace of moisture. U-tubes of calcium chloride and of soda-lime were also attached to the exit end of the cement tube and between this tube and the pump.

The loss constituents and the setting time were determined both before and after the treatment. Further quantities from the same sack of cement were then treated in a similar manner to a current of moist air, freed from carbonic anhydride and of carbonic anhydride itself respectively, and examined in the same way. The results indicate that pure, dry air has no effect upon the setting time of cement, the loss constituents remaining practically constant.

On the other hand, the effect of moist air freed from carbonic anhydride is distinctly marked, although the percentage of moisture absorbed is comparatively small.

This is probably due to the fact that the cement taken for the experiment was already high in loss constituents, the total loss on ignition being 2.39 per cent.

The acceleration of setting time by absorption of carbonic anhydride is clearly proved.

Fineness.—The British standard specification stipulates that the fineness of grinding shall be such that not more than a certain percentage of residue shall remain upon a sieve of a stipulated mesh, under the conditions of the test. It is obvious that the most important point in this connection is to ensure that the sieves used shall be of standard and definite dimensions, and this is provided for by the following clause:

"The sieves shall be prepared from standard wire, and the diameter of the wire for the 5776 mesh shall be .0044 in. and for the 32400 mesh .002 in. The wire cloth shall be woven (not twilled), the cloth being carefully mounted on the frames without distortion."

The standard specification, therefore, stipulates that for the first-named sieve there shall be 76 warp and 76 weft wires of a definite diameter; and for the second sieve 180 warp and 180 weft wires of a definite diameter per square inch.

When sifting cement through a sieve to obtain the proportion of particles too large to pass through the interstices between the wires, the size or area of the individual holes appears to be the only condition of importance; and it is to be assumed that the intention of the framers of the specification was to ensure this condition being standard.

If a definite number of wires of a definite thickness be *equally* spaced throughout the unit of measurement, the spaces between the wires will be of definite and equal area; but the weaving of wire cloth has not yet attained such a standard of excellence as to ensure that the wires (especially in the finer counts) are spaced equally throughout the piece, or even throughout any individual inch; and I have examined many rolls of cloth which contained the stipulated number of threads, of practically the correct diameter, and yet were hopelessly inaccurate for the purpose of testing cement for fineness.

I submit that the size or area of the holes in a sieve is the real standard, and should be stipulated, the actual diameter of the threads, or their precise number per inch, being of secondary importance.

In the course of my duties it falls to me to examine and to accept or reject numerous pieces of sieving cloth for use in a number of cement works and testing laboratories, and I have formulated a specification for my own use which aims at a standard sieve, while at the same time recognizing and allowing for the great difficulty of weaving cloth of this nature with extreme accuracy.

This specification, for 180^2 sieves, I state as follows:

(1) The standard area of the holes in inches is $.00355^2$.

(2) The equivalent mesh, calculated from the actual average area of the holes, as measured, shall fall between 176^2 and 185^2.

(3) The mean variation from the standard width of holes shall not exceed 10 per cent.

(4) Not more than 10 per cent. of the holes measured shall exceed a variation of 15 per cent. from standard.

It is my practice to measure with a micrometer microscope about 300 to 400 spaces in several different parts of a roll of cloth; and I find it is possible to obtain cloth to conform to the foregoing specification, and that such cloth gives in use very fairly consistent results; whereas sieves which conform to the British specification —as worded—often give, in testing, most erratic results; in one case the difference between two sieves, both of which contained the correct *number* of wires per inch, amounting to 20 per cent. of the total residue.

Another point which appears to be overlooked is the size of the sieve itself. The British specification stipulates that 100 grammes of cement shall be sifted for a period of fifteen minutes, but does not specify the total area of the sieve to be used. I have seen in use sieves varying in size from 4 in. diameter to 9 in. or 10 in. square; and it is obvious that the same weight of cement, sifted for the same period of time, will be more effectively sifted over a larger area than over a smaller one.

The following actual experiments bear this out: A sample of cement was thoroughly mixed, and 100 grammes sifted for fifteen minutes through each of two sieves prepared from the same wire cloth, but differing in sifting area. The larger sieve had a total area of 64 in.^{2}, while the smaller one had a total area of 12 in.^{2}.

The residue on the larger sieve was 16.4 per cent., while on the smaller sieve it was 19.8 per cent., a difference of 17 per cent. of the total.

Another and very finely ground sample, tested in the same was, gave 3.5 per cent. of residue on the larger sieve, and 5.6 per cent. on the smaller one—a difference of 37 per cent. of the total. I admit this is an extreme case, and that nobody in his senses would nowadays use a sieve so small as 4 in. by 3 in. Nevertheless, this sieve was actually in use not so very long ago.

Specific Gravity.—The specific gravity test is now used in place of the old method of taking the weight per striked bushel, which has for some time been discredited, and rightly so.

The weight per bushel had no real bearing upon or relationship to the degree of calcination, but was chiefly influenced by the fineness of grinding. The fallacious character of this test was well known to cement experts long before its abolition from so-called up-to-date specifications, in some of which it appears, even to-day, as the "weight per litre test.'

The specific gravity test is still retained in the British standard specification, and is considered by most people to fulfil the functions formerly attributed to the bushel weight test—viz., to detect the degree of burning to which the clinker has been subjected—or, in other words, it is a test for under-burned cement. This, however, is a fallacy. The specific gravity of cement affords no indication of the degree of calcination, and it has long been known that the figure was affected much more by atmospheric influence than by any difference in burning. This is recognized by the standard specification so far that the specific gravity is stipulated to be 3.15 when freshly burned and ground, and 3.10 when the cement has been ground for one month. This difference of .05 is a greater difference than lies between the gravities of good clinker and the lightest under-burned "yellow" respectively, as will be presently pointed out.

The specific gravity of carbonic anhydride and of water being .88 and 1.00 respectively, it will be readily seen that comparatively small proportions of these substances, absorbed from the atmosphere, are sufficient to reduce the gravity of cement to a material extent.

Butler has shown that if the absorbed water and carbonic anhydride be expelled by igniting the cement, the specific gravities of cements of various makes become so nearly identical as to afford no indication of quality.

The conclusions reached by Butler were: (1) That the specific gravity of cement is no indication whatever of proper calcination. (2) That the specific gravity depends upon the age of the cement, and the opportunities it has had of absorbing water and carbonic anhydride from the air.

These conclusions are quite in accord with the experience and the opinion held by myself for some time past.

In 1904 or 1905 F. M. Meyer found, as the result of some hundreds of tests on freshly burned clinker, that the highest specific gravity was obtained when the clinker was burned at a temperature of 1,290 deg. to 1,370 deg. Cent. This clinker gave cement which was expansive and unsound.

As the burning temperature was raised, the specific gravity was decreased, but the clinker became sound.

My own experience is that when taken freshly from the kiln, the specific gravity is practically the same, whether the clinker be well burned or under-burned, provided the carbonic anhydride has been all, or nearly all, expelled from the chalk.

The specific gravity of cement being merely a measure of the degree of aëration which the sample has re-

ceived, and the finer particles being naturally more absorbent of water and carbonic anhydride than the coarser pieces, it follows that a finely ground cement containing much flour will more rapidly have its original specific gravity reduced by aëration than will a coarsely ground sample, and would thus, falsely, appear to be the more lightly burned of the two.

Standard Sand.—There is a somewhat general idea that tensile or crushing tests of cement with standard sand represent the best results of which the cement is capable. This is erroneous. Sand tests do not give the highest results which can be got out of the cement, but give results which are standardized, and therefore comparable with those obtained by different operators. The crushing strength, especially, of concrete or mortar, depends largely upon the size and character of the aggregate, the absence or presence of dust, clay matter and other things, and the density of the mass. The use of standard sand merely gives results which are comparable, and only represent the strength of a cement when tested under certain conditions and with an aggregate of a definite size and character.

The standard sands employed and specified in different countries vary in size to some extent. These differences in size of grain doubtless have their effect upon the results obtained.

From results obtained by me it appears that the crushing resistence of concrete made from the same cement varies not only with the size, but also with the character of the aggregate.

Autoclave Test.*—This test, recently proposed by Mr. H. T. Force, in charge of testing materials on the Delaware, Lackawanna and Western Railroad, of Scranton, Pa., is merely a revival of Dr. Erdmeyer's high-pressure steam test introduced in Germany about 1881, and rejected by German cement experts as being unreliable and misleading. In the words of Prof. Gary, of the Royal Bureau of Material Testing, it is even less adapted to distinguish useless cements from useful cements than the usual methods of determining constancy of volume. According to Dr. Cushman, of Washington, the details of the test have been several times revised during the last twelve months, but the procedure is now as follows:—

For each test three neat briquettes are made, and after twenty-four hours in a moist closet these are weighed and then placed in the autoclave, sufficient water being added to cover them. Pressure is then raised by heating the apparatus by gas burners or other suitable means, the time taken to raise the pressure to 295 lb. per square inch being not more than one hour.

The pressure is maintained at 20 atmospheres for a further period of one hour, at the end of which time the autoclave is slowly blown off, the briquettes removed (when their condition permits) and placed in the moist closet for one hour. They are then re-weighed and broken in the cement-testing machine in the usual manner. The tensile strength so obtained is compared with that of twenty-four-hour neat briquettes kept in moist air, and must show an increase of at least 25 per cent. over the latter. The autoclave briquettes must also develop a strength of at least 500 lb. per square inch, and the gain in weight must not be greater than 1 per cent. Expansion bars, 1 sq. in. in section and 6 in. long, are also made up and tested for expansion after twenty-four hours in the moist closet and two hours in the autoclave. The expansion of these bars must not exceed one half of 1 per cent.

Under this test some cements develop greatly increased strength while others were reduced to powder. Comparison of results, extending over twelve months, showed that the failure could not be due to the presence of free lime; but it was thought to be due to the presence of coarse granules of cement which are not hydrated when the cement is gauged, but which might threaten the stability of the structure by subsequent hydration after a lapse of time.

The disruption of the briquettes by the hydration of the coarser particles of cement clinker, under high pressure and heat, is probably correct. I myself drew attention to this in an article published more than six years since, but numerous experiments have convinced me that such coarser particles hydrate eventually in the cold without expansion. If it were otherwise the whole of the concrete work, in this and other countries, carried out with coarsely ground cements during the last twenty years, should now be in a very precarious condition.

I have made a number of tests with the autoclave with somewhat erratic results, but with finely ground modern rotatory cements the Le Châtelier expansion of which did not exceed 2 mm., the whole of the samples, with one exception, conformed to the test as laid down. The one exception, curiously enough, was the most finely ground member of the series, the residue on the 180^2 sieve being only 1.6 per cent.

On the other hand, a number of samples ground to the fineness stipulated in the standard specification—viz., from 12 to 18 per cent. on the 180^2 sieve—failed to withstand the conditions of the autoclave test, although they were perfectly sound when tested by the ordinary boiling or Le Châtelier methods.

I hold that growth of strength by age is of less importance and is not such a criterion of quality as is generally considered. Modern cements prepared from purer clinker, and much more finely ground than formerly, attain a strength approximating to the maximum much more quickly, and it is evident that a cement which attains, say, .8 of its maximum strength at short dates has less margin for growth than one which only develops .5 of the maximum in the same time.

The stipulated pressure to be maintained in the autoclave (20 atmospheres) is needlessly high, and serves no useful purpose. The same effect is produced at a pressure of 5 atmospheres as at 20 atmospheres.

There is, therefore, nothing to be gained by carrying out the test at the high pressure advocated in America.

With regard to the utility of such a test, it must first be shown that cements which pass the simpler soundness tests generally employed in this country will yet be dangerous in ordinary work, and secondly, that the autoclave test will detect such cements with certainty. So far neither of these points has been demonstrated.

Free Lime.—No theory connected with Portland cement has obtained a stronger hold, or has attained such hoary antiquity, as the idea that unsoundness of cement is due to free lime locked up within the particles of the ground material. In fact, this theory has been for so long accepted that to question it may possibly be met with derision.

Nevertheless, I confess I have never been a believer in this bugbear, the existence of which has never been demonstrated, although many abortive attempts to do

*See *The Canadian Engineer* for Sept. 11, 1913, (p. 444).

so have been made. Certainly free lime, in the sense in which it has generally been understood, cannot produce the blowing or disruption which occurs with unsound cement, because an addition of free lime, in the form of ignited calcium oxide, has the effect of reducing expansion by inducing the hydration of particles of hard clinker grit, in the same way that ammonia or ammonium carbonate does so.

The improvement in soundness, brought about by the exposure of cement to a damp atmosphere, lends some apparent support to the contention that free lime is thereby slaked and rendered harmless; but it is rather difficult to understand how the small amount of moisture absorbed from the air penetrates the particles and slakes the free lime when the enormously greater quantity of water used in gauging the cement fails to touch it. Furthermore, unsound cement stored for some time in airtight receptacles, in which, presumably, no slaking of free lime can occur, becomes perfectly sound.

Exposure of cement to air for a few days sometimes results in an increase in the amount of expansion, as tested by the Le Châtelier method, and this increase is nearly always proportionate to the amount of aëration undergone—i.e., the thinner the layer in which the cement is laid out, the greater the increase of expansion.

This phenomenon was pointed out by me in an article published in 1907, and was the subject of a paper presented to this institute by Mr. Butler in 1910. The facts are therefore well authenticated, and they are directly opposed to the theory that expansion of cement is caused by free lime.

We know very little yet of the properties of lime in a state of solid solution. It is stated to be crystalline and to hydrate slowly; but if the solid solution theory be correct, crystalline free lime is present in considerable quantity in all Portland cements, whether sound or unsound, and it has not been satisfactorily explained why the lime hydrates without expansion in one cement, but does so with destructive force in another.

It is also well known that a low-limed cement is often more unsound than a high-limed cement, which, again, is antagonistic to the free lime theory.

My own view is that unsoundness in cement is probably due to the presence of an abnormal silicate, perhaps dicalcium silicate, which is an unstable compound and slowly disintegrates with an increase in volume. The phenomenon of "creeping clinker," known to cement makers, is an illustration of the disintegration, with increased volume, of dicalcium silicate, which is formed when clinker contains an insufficiency of lime; and this or a similar compound is most likely to be found in unskilfully made cement in which the proportions of lime, silica, and alumina are not present in correct combining weights, or when the temperature of burning is insufficiently high to induce the formation of those silicates and aluminates which constitute true Portland cement.

A new departure on the part of the government of Great Britain recently, and one which caused great comment, was the request made to four private firms to tender for the construction of submarines of a new type, and concerning which the greatest secrecy has been maintained. The new type is said to be as far in advance of previous submarines as the Dreadnought is over the pre-Dreadnoughts. It is said to have a speed of over twenty knots, with a wide radius of action. It will be equipped with wireless; its guns will be superior to the armament of the present destroyers; and it is expected to revolutionize naval warfare.

ECONOMIC CONDUIT LOCATION.

THE paper entitled "Economic Canal Location in Uniform Countries," by Lyman E. Bishop, Assoc. M.Am.Soc.C.E., which appeared in Vol. 74, Transactions Am. Soc. C.E., contains a series of interesting and useful diagrams, by the use of which the locating engineer can quickly determine the economic centre line cut for any particular canal section for any slope of ground. The subject is followed up, particularly in several of its phases, by C. E. Hickok, Assoc.M.Am. Soc.C.E., in a paper appearing in the December Proceedings of the Society, who claims that every conduit, unless it is in a country of uniform topography, must change at certain points from one type of construction to another, in order to be built economically and safely. It is rarely that a conduit of any considerable length can consist entirely of canal section, but rather it must change to flumes, siphons, pipes, bridge flumes, or tunnels, as the conditions demand. The points of change are determined,

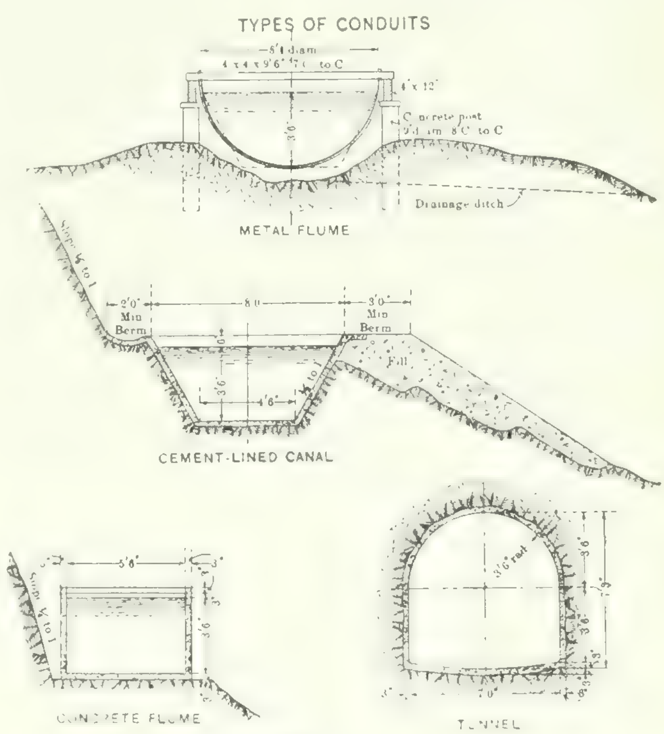

Fig. 1.

not only by the slope of the ground, the nature of the material encountered, and certain local conditions, but by economic considerations as well.

In making conduit locations, from time to time, the writer has evolved a diagram, giving the equivalent lengths, from an economic standpoint, of various types of conduit, which has been of considerable value. For instance, when the locator comes to a point where he must decide whether to tunnel through a ridge or follow the grade around with a canal, he measures the length of the two possible routes, and, by an inspection of the diagram, comes to a ready decision. This not only eliminates considerable loss of time, but, if the diagram has been properly constructed, assures a proper and complete comparison between the two alternatives as to first cost, depreciation, head-loss values, evaporation and seepage loss values, interest, taxes, inspection, and repairs.

For purposes of illustration assume a case where the project under consideration is to be used for irrigation

and hydro-electric purposes, and where the conduit has a capacity of 44.6 cu. ft. per sec. and a slope of one-tenth of 1 per cent. Four types of conduit are shown in Fig. 1.

It is obvious that for each foot saved in length of conduit there is a saving in head loss, as well as in evaporation and seepage losses. The value of this saving is ascertained in the following way, taking 1,000 ft. of conduit, for convenience in calculating:

Head Loss.—1,000 ft. of conduit dissipates 1 ft. head. With a discharge of 44.6 cu. ft. per sec., and 77% efficiency, the horse-power is

$$\frac{1 \times 44.6 \times 62.5 \times 0.77}{550} = 3.9 \text{ h.p.} = 2.8 \text{ kw.},$$

less 10% for transmission and transformer losses
2.61 kw. at $55 .... $ 143.50

Evaporation Loss—Power Value.—Assuming an evaporation of 5 ft. per annum:

$$\frac{8 \times 1,000 \times 5.0}{43,560} = 0.915 \text{ acre-ft. per year}$$

= 0.0025 acre-ft. per 24 hours = 0.00125 cu. ft. per sec. with a head of 1,500 ft.

$$\frac{0.00125 \times 1,500 \times 62.5 \times 0.77}{550} = 0.162 \text{ h.p.}$$

= 0.121 kw.,
less 10% for transmission and transformer losses
= 0.109 kw. at $55 .... $ 6.00

Seepage Loss—Power Value.—From tests made by Elwood Mead, M. Am. Soc. C.E., and B. A. Etcheverry, Assoc. M. Am. Soc. C.E., at the University of California, the writer concludes that the rate of percolation through a 3-in. canal lining under a head of 3.5 ft. is about 0.0043 ft. per hour, or 0.103 ft. per 24 hours.

$$\frac{8 \times 1,000 \times 0.103}{43,560} = 0.0188 \text{ acre-ft. per 24}$$

hours = 0.0094 cu. ft. per sec.

$$\frac{0.0094 \times 1,500 \times 62.5 \times 0.77}{550} = 1.23 \text{ h.p.}$$

= 0.92 kw.
less 10% = 0.828 kw.,
0.828 kw. at $55 .... $ 45.54

Total annual power loss	$ 195.04
Capitalized at 10%	$1,950.40
or per foot	1.95

Evaporation Loss—Irrigation Value.—0.0025 acre-ft. in 24-hours (from the foregoing) = 0.00125 cu. ft. per sec. = 0.0625 miner's inch. Assume 25% loss before delivery to consumer:

0.047 miner's inch at $0.40 per miner's inch per day = per annum .... $ 6.86

Seepage Loss—Irrigation Value.—0.0188 acre-ft. per 24 hours (from the foregoing) = 0.0094 cu. ft. per sec. = 0.47 miner's inch, less 25% loss = 0.353 miner's inch at $0.40 per miner's inch per day = per annum 51.64

Total annual irrigation loss	$ 58.50
Capitalized at 10%	585.00
or per foot	0.585

Résumé:

Power loss per foot	$1.95
Irrigation loss per foot	0.585
Total loss per foot	$2.535

The first cost and the annual charges of each type of conduit are next computed. The annual charges are taken as consisting of the following items: interest, depreciation, taxes, inspection, and repairs. The annual charges of each conduit are capitalized at 10% and added to its first cost, which gives a figure having a real comparative value. For instance, we obtain the comparison between a lined canal and a concrete-lined tunnel as follows:

Concrete-Lined Canal.

First Cost—Per Foot—		
Excavation, 2 cu. yd. at $0.36......	$0.72	
Concrete, 4.25 cu. ft. at $10.20 per cu. yd.	1.57	
		$2.29
Annual Charge—		
Interest at 10%	$0.23	
Depreciation at 2%	0.046	
Taxes	0.019	
Inspection	0.01	
Repairs	0.02	
	$0.325	
At 10%		3.25
		$5.54

Concrete-Lined Tunnel.

Excavation, 2.25 cu. yd. at $5.50 ...	$12.40	
Concrete and forms	4.10	
		$16.50
Annual Charge—		
Interest at 10%	$1.65	
Depreciation at 1%	0.165	
Taxes	0.137	
Inspection	0.01	
Repairs	0.02	
	$1.982	
At 10%		19.82
		$36.32

It is evident, if we shorten the conduit by building the tunnel, that the first cost and the capitalized annual cost of the tunnel can exceed the first cost and the capitalized annual cost of the canal by an amount equal to the length of conduit saved multiplied by the loss value per foot of conduit. This is shown by the equation:

$$Y(C_y + A_y) - X(C_x + A_x) = (X - Y)V$$

where X = linear feet of canal,
Y = linear feet of tunnel,
C_x = estimated cost per foot of canal,
A_x = estimated annual charges per foot of canal capitalized at 10%,
C_y = estimated cost per foot of tunnel,
A_y = estimated annual charges per foot of tunnel capitalized at 10%,
and V = value of losses per foot of conduit.

In the case of a tunnel, the evaporation will be considerably lessened, thereby effecting an additional saving. If entirely eliminated, this saving would amount to 12.8 cents per ft., as shown above. This was reduced to 10 cents and the first cost of tunnel credited with that amount. Inserting the proper values in the equation:

$Y(16.40 + 19.82) = X(2.29 + 3.25) + (x - y) 2.53$

$Y = 0.208 X$, the equation of a straight line.

In the same way, any two types of conduit can be compared and the resulting straight-line equation obtained. The diagram, Fig. 2, which is self-explanatory, shows the results.

In the case where a siphon crossing a gulch is compared with a canal or flume passing around the head of the gulch, the cost of the siphon is credited with the saving in evaporation and seepage throughout its length, which in this case amounts to $1.10 per ft.

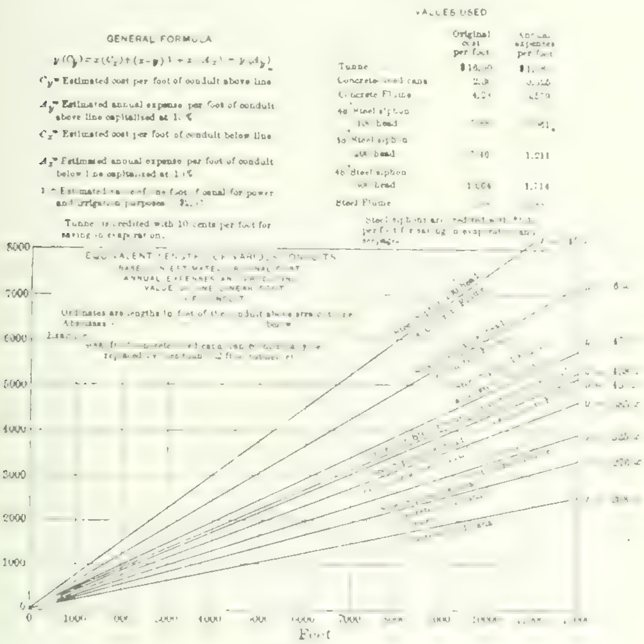

Fig. 2.

The writer realizes that such a diagram cannot be relied on entirely in the location of a conduit, for there are local conditions on every piece of work which must be taken into account.

M. Claude Casimir Perier has published two exhaustive volumes dealing with facts and figures concerning the utilization of the geographical and physical advantages of Brest, and the transforming of the deepest, broadest and best port of western Europe into the great Old World centre for maritime commerce with North, South, and Central America, and, by means of the Panama canal, with the Pacific coast of America and Asia. He shows that Brest is, with the exception of Lisbon, nearer to Colon than any other port in Europe, being only 4,412 miles distant from the Panama canal, 2,954 from New York, and 4,873 miles from Rio de Janeiro. It is not affected by the tidal difficulties encountered off Havre and the ports of the English channel; and it is larger than any other port of Europe. Its depth of water is twelve metres alongside the quays and at the shallowest part of its channel; and this could with comparatively slight cost be deepened to fifteen metres. Brest is only 624 kilometres (389 miles) from Paris, and with improvements on the French railroad lines, would become the terminal of a trunk line to Paris and would also be connected by means of three other trunk lines, not touching Paris, with Calais, Belgium, Germany, Switzerland and Italy. It can also be readily made the feeding point for the French inland canals. The scheme also includes the establishment of a great central railroad station in Paris, possibly near the Palais Royal, which would place the other main line terminals in Paris in communication for passenger and freight. The total cost is estimated at $530,000,000; but M. Perier points out that during the last eighty years France has paid more than five times this sum on the improvements of its ports alone, and to-day has not a single one that can accommodate 50,000-ton liners.

COMPARISON OF WOOD PAVING IN EUROPEAN COUNTRIES AND IN AMERICA.*

By S. R. Church,

Manager Research Dept., Barrett Manufacturing Co.

It has been stated that creosoted wood blocks make the ideal pavement if the following faults could be eliminated: The tendency to expand, resulting in bulging, and sometimes upheaval of the pavement; dislocation of curbs, etc. Slipperiness. Exudation of oil, or "bleeding."

Therefore, in any comparison of our pavements with those of Europe, it is natural first to inquire whether these faults are observed in the European wood pavements, and if not, why not.

Of all the wood pavements that I saw in London, Paris, Berlin and other cities, none of them exhibited any of the foregoing defects, with the exception of two or three slight bulges noticed in London.

Two incidents that have come under my observation within the last few months may be worth relating here. One is the case of a wood pavement recently put down in one of our largest cities on an important business street. A few days after the work was completed I noticed twenty or thirty blocks comprising three parallel rows for a distance of six or seven feet across the pavement, laid with the grain horizontal instead of vertical. After a few weeks, this was apparently brought to the attention of the contractors, and the blocks taken up and relaid. The other incident was the rejection of a low bid on a good-sized wood paving contract, because the sample of oil submitted with the bid yielded, on distillation, one-half of one per cent. more at a certain temperature than the specification allowed. I am perfectly certain that neither one of these things could possibly happen in London. Perhaps nothing that I can say will better illustrate the difference in conditions.

Wood Paving in England.—Creosoted wood is, without question, the most highly esteemed paving material in the English cities. In ten of the twenty-eight boroughs constituting the City of London, and comprising the most thickly populated sections of the city, the total mileage of creosoted wood block in 1912 was 121, and of this total 40 miles was in the City of Westminster. As most of you know, Westminster is that part of London containing the best retail business streets; the government buildings, theatres, museums, art galleries, etc., the social heart of the city. The streets of Westminster are important thoroughfares. The traffic is, however, very largely rubber-tired. In fact, the percentage of iron-tired traffic, if known, would probably be surprisingly low. There are a few exceptions, such as the Strand, where there is considerable mixed traffic, but on the whole, the streets of Westminster and those of purely residential boroughs, such as St. Mary Lebone, Kensington and Wandsworth, which together contribute ninety miles to the total of London wood paving, carry a traffic comprising a tremendous number of vehicles, but of a very non-destructive character to pavement. The City of London proper contains only eight and one-half miles of wood paving. Here the traffic is, of course, intense in all respects.

*Extract from a paper presented at the annual meeting of the American Wood Preservers' Association, New Orleans, Jan. 20th, 1914.

All of the other English cities have adopted wood paving for some of their best streets. Liverpool has approximately 150,000 square yards; Birkenhead, 95,000; Birmingham, Nottingham, Bristol, in fact, all English cities over 50,000 population have wood block streets, and in the majority of cases these are the principal thoroughfares of the town.

I have already stated that European pavements did not bleed; that they are not slippery; and that, at least so far as my own observations are concerned, there is very little expansion sufficient to cause trouble. In England two classes of wood paving exist, soft and hard The hardwoods are ordinarily laid untreated, and will not be considered in this paper, except to state that they are going out of favor very rapidly, and that the existing hardwood pavements are, as a rule, rough and noisy. These pavements comprise the Australian Jarrah and Karri, species of Eucalyptus. Great things were hoped of these woods when first introduced, but their use has unquestionably proved a failure. The creosoted softwood pavements presented, in general, a good appearance, but not equal to the appearance of our best wood block streets. I have said that they were not slippery. This is because the wood is soft enough to permit the pounding into the fibre under traffic of the gravel or coarse sand which is spread over the pavement, and the pieces of grit become permanently embedded in the surface of the wood. It can readily be understood that such a surface will not be slippery. It can also be readily appreciated that it will not present as attractive an appearance, nor would it be quite as noiseless as our creosoted yellow pine.

The wear of the blocks is, in general, very uniform, and but few streets are seen where depressions, pot-holes or inequalities in the surface exist, although in the downtown streets of London proper, where traffic is heaviest, there are several exceptions to this general good condition.

From a casual observance of the wood block surfaces in London, one accustomed to the appearance of our pavements marvels at the apparent absence of replacements. It requires very close scrutiny of the pavement to find the places where service cuts have been made, and where the pavement has been patched. The great care with which this work is done to produce such good results is in marked contrast with the careless manner in which the blocks are sometimes thrown back into place after a service cut in one of our city streets.

I was able to visit the treating plant of one of the most important paving block companies. They are using almost exclusively wood of the class known as "pinus sylvestris," and which is sold under various names, such as "Swedish pine," "Baltic pine," "yellow deal," "red deal," etc. I found this to be a most uniform appearing wood, block after block could be examined without any noticeable difference in weight, size of rings, freedom from knots, shakes, etc., nor is there as marked a difference apparent between heart and softwood as in our yellow pine. The manager of this company told me that he has made a study of wood for many years, and has been all over the world, and that in his opinion this Baltic pine is the ideal paving block wood, and to it he ascribes the success of their pavements. The methods in the plant appear to be thorough and well regulated, but not nearly as up-to-date mechanically as our American works. The saws are small; the treating cylinders are small, and there is a great deal of hand labor. Straight pressure treatment is used. The average treatment is about ten pounds per cubic foot. The City of London now requires twelve pounds, and the city of Westminster ten pounds. The oil is coal tar creosote oil, said to be about 1.06 specific gravity. Specifications are very simple, and so far as I can learn there is practically no inspection at the plant.

Considering the apparently light treatment, the penetration of the oil is exceedingly good (sample). This company lays most of its own blocks, and a large proportion of its contracts are in London. These blocks are delivered to the street in wagons. The storage capacity for untreated or treated material at the plant is small, so that the wood is not seasoned very long before treatment, nor do the blocks remain in storage after treatment for any length of time. In most of the London paving, the blocks are delivered just about as fast as they are required. They are seldom piled along the sides of the streets.

Laying Wood Paving in London.—In company with Mr. G. W. Tillson, Commissioner of Public Works, Brooklyn, New York, I had an opportunity of carefully observing the construction of a wood pavement in Gracechurch Street, London. We were both greatly impressed with the good workmanship displayed. The street is in the heart of the old city, and is 34 feet wide. It was being paved for a distance of about six blocks. The contractors were allowed to shut the street off from traffic for a definite period of time, within which the work must be completed. The old asphalt pavement had been entirely removed, and a new cement-concrete foundation 9 inches deep, was put down. This concrete was put down in sections about 25 feet long, and the full width of the street. It was laid in one course, with a very wet mix, the metal being Thames gravel and sand. The concrete surface was finished to an absolutely true grade by means of a wood templet, and without the use of any mortar course. Sometimes a mortar course is used to make the surface smooth. In all cases the concrete is allowed to set six or seven days until perfectly hard, and the blocks are then laid directly on the hard, smooth concrete, without any cushion. This is universal practice, not only in London, but in Paris and Berlin, and all the engineers with whom I talked said that they were opposed to the use of a sand cushion or a soft cushion of any kind. The blocks were 5 inches deep by 3 inches wide by 7 inches long. They were very uniform in length and exceedingly true in depth. They were laid fairly close, but not rammed. An expansion joint 1½ inches wide was provided along either curb, and two rows of blocks laid parallel to the curb, with a pitch-filled joint between these rows. The expansion joint along the curb was filled with clay to within ½ inch of the top. Before paving up to projections, such as manholes, pipe valves, etc., the blocks are fitted with great care around all these projections. Over the finished surface after the blocks are laid, a flush coat of hot coal tar pitch, of about 140-145° F. melting point, was poured from hand buckets, and this was immediately squeegeed over the surface with rubber rollers, forcing it into all the joints. This was followed with a thin wash coat of cement grout, and finally a substantial layer of fine, brown, siliceous gravel, free from dust or loam, which was allowed to remain on the surface until pounded into the blocks by traffic.

The foregoing is typical of modern English practice. I have seen statements to the effect that spacing lath are commonly used in the joints, but this practice has been abandoned, except in the case of some hardwood pave-

ments. The spacing strips are never used in London or Paris with softwood blocks. They are, however, used in Berlin. The flush coat of pitch over the surface is the universal practice in England, although not used to any extent elsewhere. Longitudinal expansion joints are always provided, even on heavy traffic streets, but lateral expansion joints are not used. In London, 5-inch blocks are used on all important thoroughfares, and no blocks less than 4 inches deep are ever used.

Creosoted Wood Paving in Paris.—Creosoted wood block paving in Paris is more noticeable for quantity than it is for quality. Up to the end of 1911, they had 200,000 square meters, equal to about 280,000 square yards of wood paving. As in England, they have used both hard and soft woods. Hard Australian woods were used to quite a large extent, but have not given satisfactory results. The report of the Chief Engineer of Bridges and Streets of Paris, at the London Road Congress, stated that the average life of the hardwood paving was six years. The appearance of the creosoted pine pavements in Paris varies from good to exceedingly bad. There are many streets where the blocks are decayed. There are also many very rough streets, and on the whole, they are distinctly inferior to the wood block streets in any of our American cities.

Manufacture of Paving Blocks in Paris.—I was fortunate in being able to inspect the municipal wood block plant, through the courtesy of M. de Puligny. This is a very large and well ordered plant, and the first thing that attracts attention is the very high lumber piles, which approximate 40 feet. The sticks are run up into these piles direct from the cars by means of an electric tiering machine. A large proportion of the lumber is kept under glass roofs. There is also a very large storage yard for treated blocks. A new electrically driven machine, which saws 16 blocks at once, is a feature of the plant. The sticks are fed automatically to the saws, and the blocks are discharged automatically with the grain up, to the inspection table, from whence they are loaded by hand into very small iron treating cars. Five or six of these cars full of blocks are run under the creosote oil tank, where each car is filled up by gravity with oil at a temperature of 80 degrees C. After remaining in this bath of oil for twenty minutes, the oil is drawn off from the bottom of the car, and the blocks taken to the storage yard. The average absorption by this treatment is three pounds per cubic foot. Naturally, the penetration is very slight. It is not surprising that the blocks decay before they are worn out, but at first sight it is very surprising that they do not bulge and buckle continually.

An interesting feature of the Paris plant is the machines for shaving old blocks for relaying. Blocks taken up from the street, if not too badly worn or decayed, are brought to the plant and the edges trimmed on these machines. It is sometimes done with portable machines on the streets. Many of the blocks being repaired in this manner for relaying showed hardly any evidence of treatment, and some were partially decayed. The Paris engineers freely admit that their blocks have been very insufficiently treated, and that the results have been unsatisfactory, and, in fact, they are now erecting a new plant for pressure treatment by means of a process developed by M. Labordere. As he has discussed this process in a recent paper before the Sixth International Congress of Testing Materials, I will not at present describe it. M. Labordere told me that it is their intention to use, in connection with this process, a mixture of coal tar pitch and creosote oil of not less than 1.08 specific gravity. They have been using for the dipping treatment an oil of about 1.04 specific gravity.

The woods used in Paris for creosoting treatment are Baltic pine, and pinus maritimas, a native pine largely used at present. This is a much wider grained wood than the Baltic pine, and less uniform in character. They make an interesting distinction between the resinous or gummy wood from the lower part of the trunk, and the wood from the upper part of the trunk, using the former for heavy traffic streets and the latter for ordinary work. I do not know to what extent they are able to carry this out in practice.

I saw two or three wood block streets in course of construction. Five-inch blocks were being put down, and in general, the method is much the same as in London. The concrete foundation is very similar in appearance, and the absence of any soft cushion especially noteworthy. Expansion joints 1½ inches wide along the curbs are filled with sand. Two rows of blocks are laid parallel to the curb with 1-inch between the rows, a peculiar type of sectional expansion joint being used, consisting of a bituminous paper box about 6 inches long, containing hollow paper cylinders. This keeps dirt, etc., out of the joint, and crushes readily under pressure. Transverse joints about 100 feet apart are also filled with these bituminous boxes. On another street a collapsible metal expansion joint is used (Sketch). Instead of pitch grouting, it is common practice in Paris to flush the surface with cement grout, which fills the joints that are open. The work did not seem to be as well organized or as rapidly carried on, nor did the surface of the finished pavement present as uniform an appearance as the London work already described.

In another street I saw 5-inch Swedish pine blocks being laid. The grade was at least 2½ per cent. In this case the surface was flushed with coal tar pitch poured by hand, and forced into the joints by the use of hot smoothing irons. This was followed by a heavy covering of coarse sand. I was told that this method of filling joints was not as common in Paris as the cement grouting method.

Wood Block in Berlin.—There is not much wood block paving in Berlin, but a condition which seems rather remarkable exists, in that on streets paved with asphalt, where the grade becomes too steep and the asphalt will prove unduly slippery, wood block is used. Most of the approaches to bridges are paved with creosoted wood block.

Berlin has probably the finest sheet asphalt paving in the world. Their wood paving is rough and comparatively noisy. About the only thing of especial interest noted in Berlin was that a new wood block plant has been erected where the Rueping process will be used for treating Swedish pine similar to that used in England. I was shown blocks treated by this process, which appeared to have very good penetration with a minimum use of oil (sample).

In the beginning of this paper I stated that European wood pavements did not bleed, expand or buckle, and were not slippery. Let us inquire briefly into the reasons, and see what we have to learn from their methods.

Conditions are so entirely different that I do not see how any direct comparison can be made. In the first place, as to slipperiness, I have already explained that the non-slipperiness of their pavements is due to the use of softer wood. As to bleeding, they seldom have any

weather in London hot enough to cause bleeding. In Paris there is not enough oil in the blocks to cause bleeding. The climate also undoubtedly plays a very important part in the question of expansion and contraction. It is agreed that the sudden expansion that sometimes takes place in our wood pavements is due to a rapid absorption of moisture, usually after the pavements have been unduly dry. This can hardly occur in England, where they have a little rain all the time, very seldom any torrential downpours or any long continued dry spells. The average humidity is high. It is a question whether the pavements ever get dried out to anything like the extent that ours do. I should say that generally the blocks are in a maximum condition of expansion. The same must be true in Paris, or the inadequately treated blocks in that city would certainly bulge. On the other hand, it is well worth considering if the kind of wood that they use has something to do with the lack of expansion troubles. It is manifestly a very different wood from our longleaf yellow pine. As I have already stated, it does not present as attractive an appearance, and it is probably not so durable. It may be, however, that with shortleaf pine or tamarack or Douglas fir, we could obtain results more nearly approaching the European results by following their practice more closely with regard to treatment and methods of laying.

I believe we can afford to give careful consideration to the question of lighter treatment, but I do not believe that because ten or twelve pounds is ample in London with the wood they are using and the climate that exists, it would be ample for our woods in our climate.

The points that I would especially emphasize for your consideration are:—

1. The great care used in the preparation of the concrete foundation and, in fact, in the whole workmanship of the pavement.

2. The general use of deeper blocks.

3. The universal practice (in England) of sealing the joints of the pavement with coal tar pitch, so as to prevent the entrance of moisture.

I would also emphasize what I hope has been suggested to you by a reading of this paper, that the pavements in Europe (this does not apply only to wood), are laid and maintained by workmen who have more conscience, or at least, take greater pride in their work than we find on the average job in our country. There is less inspection on the part of the city of the operations of making the blocks and laying them, but I got a very strong impression that the manufacturers are taking no chances of having their material condemned on account of carelessness or bad workmanship.

In conclusion, I want to repeat that in my judgment, none of the European wood paving surpasses our best wood streets in appearance.

In a recent paper, read by Marcus Machol before the Society of Automobile Engineers, he notes among the claims of magnalium, an alloy of aluminum with 5 to 20 per cent of magnesium, that it has been used for the cylinders and pistons of gasoline engines and for other purposes, and has attracted special attention for aeroplanes and other uses requiring lightness; that its specific gravity is 2 5/10, that of aluminum being 2 6/10, and that of cast-iron, 7 5/10; and that, while tough instead of brittle, it shows a tensile strength of 23,000 pounds per square inch, cast-iron showing 18,000 to 20,000 pounds. As a bearing metal it shows less friction than babbitt or phosphor bronze. It melts at 125 degrees F., which is often exceeded in the engine cylinder, but the pistons do not get as hot as those of iron, because the magnalium heat-conductivity is 14 times as great as that of iron.

BILLINGS BRIDGE OVER RIDEAU RIVER, OTTAWA, ONT.

This bridge is required to replace the wooden structure erected in 1880 by the Township of Gloucester, Carleton County. The present wooden bridge, composed of a series of king post trusses, carried on timber cribs, is in a state of decay and collapse, so much so, in fact, that timber bents have had to be placed under the main channel spans as the bridge can no longer rely on the trusses as a whole, carrying their loads to the piers, the top chords of several of them having by this time assumed a spiral formation. The bridge marks the boundary between the City of Ottawa and the Township of Gloucester and, though at a point not yet thickly populated, is on one of the main arteries into the city. A considerable portion of the farm produce consumed in the city comes in over this route, as many as 800 vehicles and 1,200 foot passengers having been observed to cross in one day.

Disputes on the part of the township authorities as to their proportion of the cost of the new structure have been responsible for the delay in building the new bridge, which in view of the above facts is obviously needed.

The new steel bridge is a commodious structure, carrying as it does two electric car tracks, two 15-ft. roadways and two 6-ft. cantilever sidewalks, thus giving ample provision for future requirements.

It was thought by the designers that economy could best be effected by following the well-known method of making the cost of the substructure equal as near as possible that of the superstructure, and with that objective the crossing was divided into 5 equal spans of about 78 ft. each.

On account of the very high flood which occurs at this point every spring, it was impossible to use a deck construction while consideration also had to be given to the fact that land damages were inevitable at the north or Ottawa end of the bridge, because of the necessity of raising the finished road elevation above that of Bank St. (of which the bridge is a continuation). The engineers were confronted with the problem, therefore, of either incurring excessive land damages or of reducing the clearance between flood level and bridge seats to a minimum. The latter course was decided upon, a minimum clearance of 1 ft. allowed, the finished elevation of the bridge roadway being fixed some 7 ft. above that of Bank St. and the approach being commenced at a point some 190 ft. from face of abutment, which produces a grade of about 3½%.

To effect this a heavy through plate girder construction was adopted, which in combination with its floor-system reduces vibration to a minimum, and approaches the monolithic as closely as can be done in steel construction.

The main girders were designed for the worst possible condition of loading, the maximum moment for each girder being considered a criterion, with 2 cars covering the span and with sidewalks and roadway loaded to 100 lbs. per sq. ft. While this condition is an extreme, it is a condition that is not impossible. Live load stresses were increased for impact according to Ketchum's formula.

$$I = \frac{S \times 150}{L + 300}$$

where L = loaded length of bridge in feet producing the maximum stress in member;

S = computed live load stress;

I = impact to be added to live load stresses.

No remarkable features were met either in the design of the main girders or floor beams, but in the design of the floor-beam connections a common error was avoided, i.e., that of attaching the floor beam to the stiffeners of the main girders, so producing serious secondary stresses, which are avoided by riveting directly to main girder web.

Although the wind stresses in the lateral system are comparatively small it was deemed advisable on account of the great width of roadway to design these members as struts, 4 latticed angles placed 12 in. back to back being used. A double system of bracing was used in each panel as the width of roadway, 48 ft., to length of panel, 15 ft., would render a single system ineffective, besides necessitating details of an objectionable character.

The 4 piers and south abutments will be carried down to rock, test borings having shown this to be from 10 ft. at abutment to 15 ft. at north pier below normal water level.

The north abutment will be piled, concrete being taken down about 10 ft. below water level; borings show rock at this point to be about 25 ft. below water level.

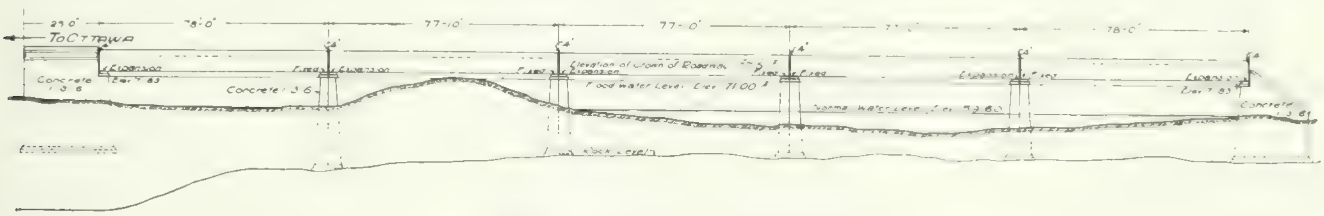

Fig. 1.—Upstream Elevation.

The City of Ottawa having only a 60-ft. right-of-way at the north approach, it was necessary to build a U abutment, keeping it as closely as possible on city property. The south abutment, however, is built with wing walls. It is quite necessary on this side as a cross road passes along the river bank, making it imperative that a good sweep be obtained for vehicles turning off on to the bridge. A U abutment would obviously be dangerous to traffic under these conditions.

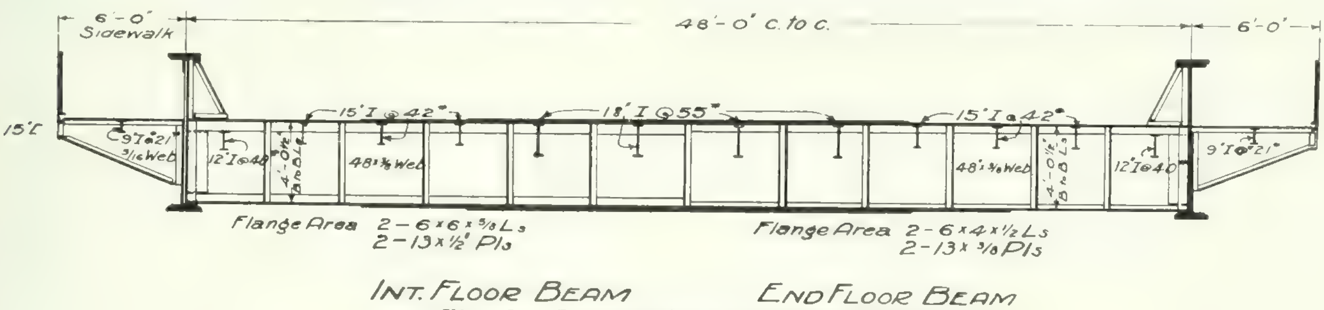

Fig. 2.—Cross-section of Billings Bridge.

Expansion is provided for in the usual manner by roller bearings.

The roadway is carried on a 4½-in. reinforced concrete slab, supporting a 4-in. creosoted wood block wearing surface placed on a 1-in. sand cushion, drainage being effected by a camber of 6 in. at the crown of the roadway, and weep holes being placed at the centre of each panel about 2 ft. from each main girder.

Traffic will be maintained during the erection of the new bridge, by a temporary structure placed about 100 ft. east of the present bridge.

The superstructure was proportioned to carry the loads specified for electric railways on Diagram "B" of the Dominion Government specifications for bridges and for a 16-ton road roller at any point on the bridge.

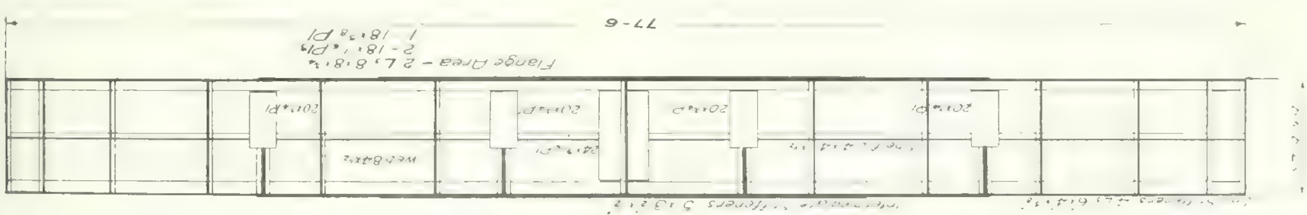

Fig. 3.—Inside View of Main Girder.

Sidewalks are formed with a 3-in. reinforced concrete slab with 1-in. cement finish, with a slight slope outwards sufficient to drain.

Designs for sub- and superstructure were carried out under the direction of Mr. Archibald Currie, city engineer, Ottawa, Ont., Canada.

The largest turbines yet constructed are those constructed for the new Cunard liner, the "Aquitania." They weigh about 1,400 pounds, and have cost thousands of pounds in both experiment and construction. The company has benefited by the experience gained from the building and running of their other turbine ships, so that, in the case of this new vessel, an exceptionally high degree of economy is maintained by passing steam successfully through high-pressure, intermediate, and low-pressure turbines to the condenser, instead of, as formerly, direct from high to low pressure. This ensures more work from both coal and water. A special feature is the arrangement made for going astern. Each of the four propeller shafts has an independent turbine for this purpose. There will be over a million turbine blades in the engines, which, if placed end to end would reach more than 140 miles.

PUBLIC WORKS MELFORT, SASK.

By Roy G. Sneath, B.A.Sc.

THE town of Melfort is situated in Northern Saskatchewan. It is approximately 60 miles east of the city of Prince Albert, and 500 north-west of Winnipeg on the Swan River-Prince Albert branch of the Canadian Northern Railway. A branch line south from Melfort to Humboldt, Sask., on the Winnipeg-Edmonton main line of the C.N.R., is nearing completion.

Fig. 1—Interior of Power House, showing Switchboard and Compression Tanks.

The town has a population of about 1,600, composed almost entirely of English-speaking people. The surrounding country is probably the richest and best suited for mixed farming in the province, and the town has every prospect of rapid and substantial growth.

In the fall of 1911 the town council called on Messrs. McArthur & Murphy (now Murphy & Underwood), consulting engineers, of Saskatoon, for estimates covering the cost of waterworks, sewers and electric lighting system for the town. Accordingly plans and specifications were rendered by the engineers and were approved of by the town. Contracts were let approximating $150,000 and construction started during the middle of the 1912 summer season.

Power House Structure and Equipment.—The power house, situated ½ mile south-west of the main part of the town, is a brick and hollow tile structure, 40 ft. in width and 70 ft. long. The walls are about 20 ft. high, rising to a peak roof, and are made up of 4½-in. brick backed by 4½-in. of hollow tile. Figs. 1 and 2 are interior views.

The power is supplied by a 150-h.p. Diesel oil engine, direct connected to a 90-k.w., 22,000-volt, 3-phase, 60-cycle generator, which is in turn direct connected to an exciter, a shown in Fig. 2. The switchboard is composed of 3 panels of blue Vermont marble. The first controls the generator and exciter; the second controls approximately ninety 100-watt, 6.6-ampere series tungsten street lamps. The third, or motor panel, takes care of the various motors in the power house and another at the deep well. The generator, exciter and switchboard were supplied and erected by the Canadian General Electric Company. The Canadian Boving Company supplied and installed the engine.

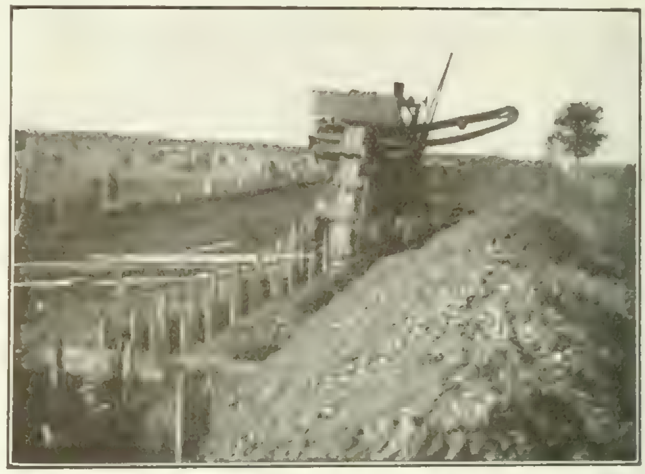

Fig. 4—Excavating 20-ft. Trench from Town to Disposal Works.

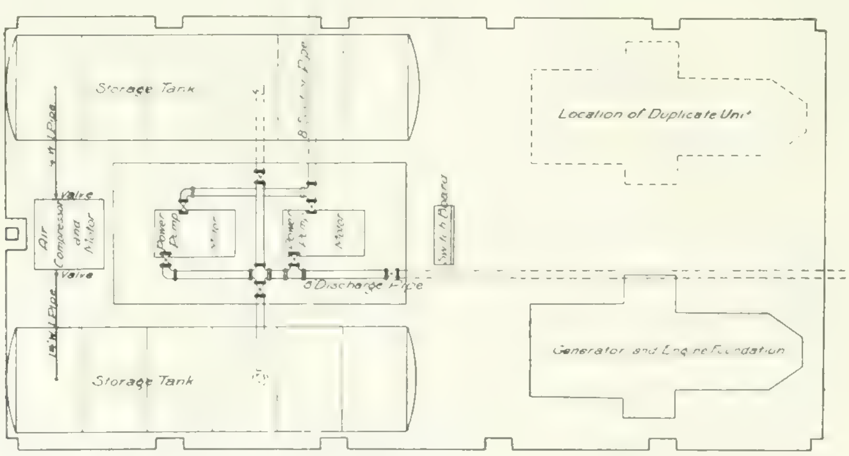

Fig. 3.—Plan Showing Arrangement of Machinery in Power House.

A 5-ton travelling crane was installed in the power house, and proved itself almost indispensable during the installation of the machinery.

Water System.—The source of water supply is in a gravel bed two miles westward from the town. After tests were made to assure sufficient flow of water a circular well was sunk to about 18 ft. in depth, with an inside diameter of 20 ft. It is a concrete structure, with walls 12 in. thick to the ground line and 9 in. above the surface. A reinforced concrete floor at the ground line carries a 20-h.p., 3-phase, 220-volt vertical motor, which

is direct-connected to a submerged centrifugal pump, capable of delivering 300 gal. per minute against a 60-ft. head. This pump discharges through approximately 10,500 ft. of 8-in. steel pipe into a rectangular concrete reservoir, 24 x 64 x 15 ft. deep, which is located near the power house.

each with a capacity of 300 Imp. gal. per min. against a pressure of 80 pds. per sq. in., are located in the power house, and pump water directly into the town mains, or into the pressure tanks. The pressure tanks are connected by a 1¾-in. wrought iron pipe to a horizonal double-acting air compressor, which is back-geared to a

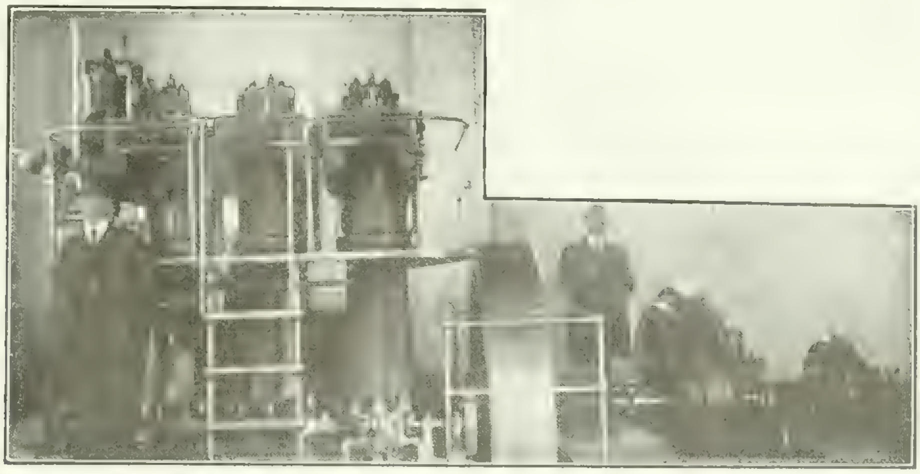

Fig. 2—Diesel Engine with Direct-connected Generator and Exciter, Melfort Power House.

Pressure is maintained on the town mains by a compressed air system, the pressure being obtained by means of compressed air instead of by actual head of water in a standpipe. In the power house are situated

20-h.p. motor. The compressor is capable of displacing 80 cu. ft. of free air per min. against a pressure of 100 pds. per sq. in. The power house arrangement is shown in Fig. 3.

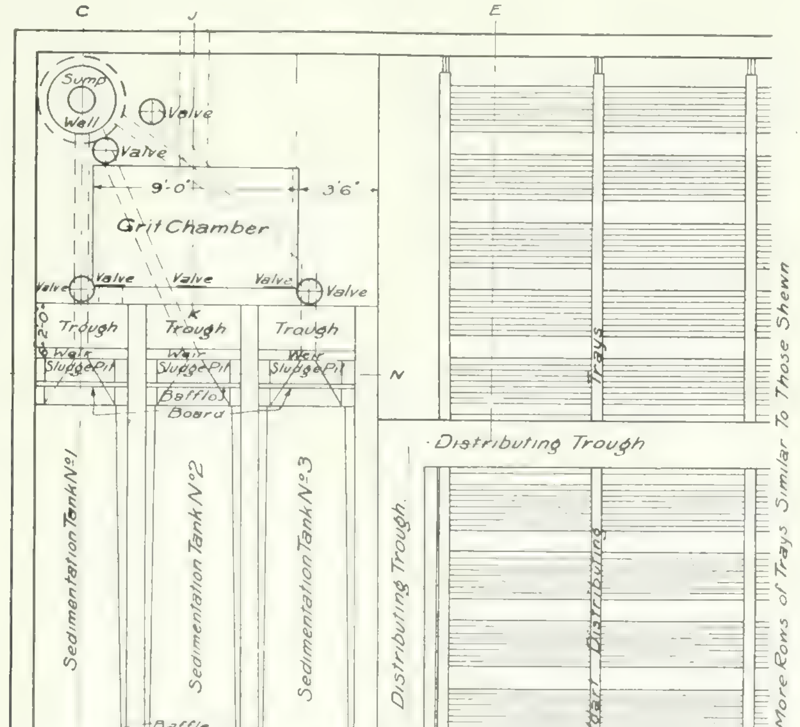

Fig. 5.—Plan of Part of Disposal Works Showing General Arrangement.

on suitable foundations, with major axes horizontal, two cylindrical steel pressure tanks, each 35 ft. long by 8 ft. in diameter. Two 3-stage, horizontal turbine pumps,

Valves are so located that either or both pumps may deliver to either or both pressure tanks or directly into the town mains. Or, the pumps may be shut down and

by using the air compressor any desired pressure up to 125 pds. per sq. in. may be maintained in the tanks and town mains till the last drop of water has left the power house.

Weldless steel water pipe is used throughout, averaging about 20 ft. per length.

Sewer System.—The sewer system (which operates by gravity) is purely sanitary, no storm water having access. At all dead ends of lateral sewers, Miller flush tanks were placed. Some of the grades were so low, owing to the level nature of the ground, that this was deemed advisable as a precautionary method.

Lateral sewers, 8 in. and 12 in. in diameter, discharge into a 15-in. trunk sewer, which runs along the main street in a northerly direction for approximately ¾ of a mile and then turns east for ½ mile toward the disposal works. Fig. 4 shows a Parsons digging machine at work on the sewer trench, excavating to a depth of 20 ft. with a width of 3 ft.

The Disposal Works.—Sewage enters a grit chamber 9 ft. x 5 ft. 4 in. From the grit chamber the sewage is discharged through three valves into distributing troughs which feed three sedimentation tanks, each 18 ft. long x 4 ft. wide x 4.5 ft. average depth. Any one of these three units may be shut down for cleaning purposes without interfering with the continuous operation of the plant.

Sludge valves placed at the low end of the sedimentation chamber permit of the sludge being drawn off into a sump well. From this it is pumped by a hand-operated sludge pump into wheel-barrows.

After sedimentation the effluent from the tanks flows over a weir into a distributing trough, which feeds a trickling filter-bed by means of Stoddart trays. The filtering material used is screened gravel, averaging 5 ft. 25 in. in depth over the filter-bed.

The method of under-draining the filter-bed is very simple. The entire floor slopes toward the centre and towards the manhole at the outlet end. Half-tile were laid with open joints down the centre and coarse stone piled around them. Figs. 5 and 6 show a half plan and details of design of the plant.

From the outlet manhole the clarified liquor is discharged into a stream 300 ft. distant. A by-pass was constructed so that in case of emergency the raw sewage might be discharged directly into the stream. The discharge of unclarified sewage into the stream would, of course, be very undesirable, and it is not expected that this auxiliary outlet will ever be brought into use.

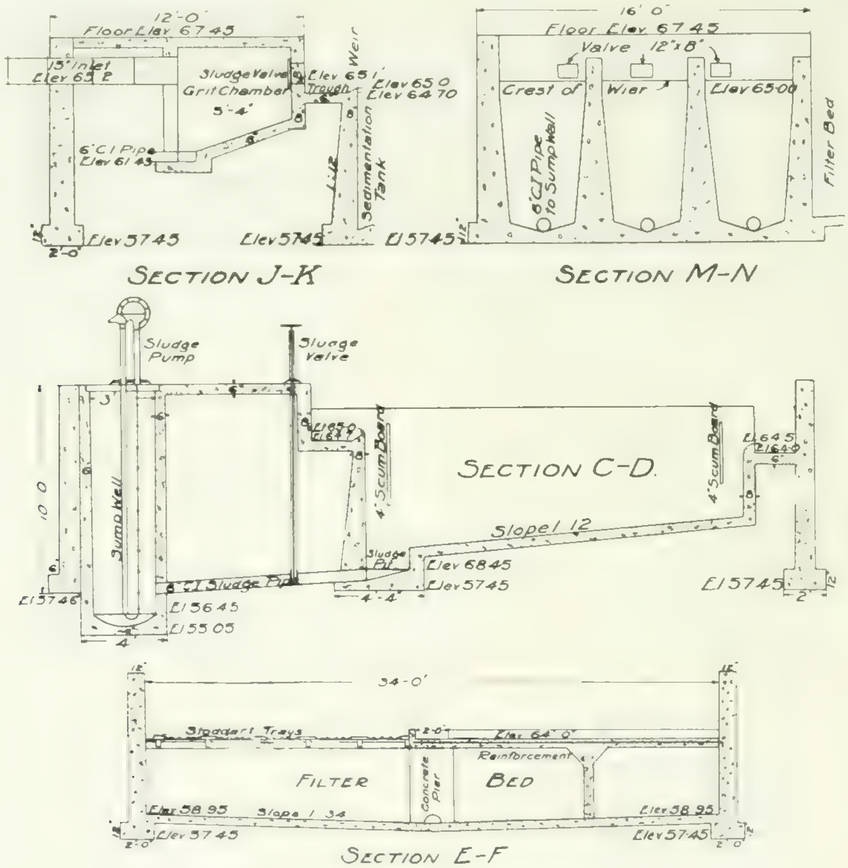

Fig. 6.—Details of Disposal Works of Melfort, Sask.

The disposal works are entirely enclosed by a frame building with a corrugated iron roof.

Similar systems have been installed and are being successfully operated in Yorkton and other Western towns, while contracts have been let and work is being proceeded with in Le Pas, Man., and Sutherland, Sask.

Memoranda has been issued by the Imperial Trade Commission of London, England, which has been prepared by Lord Pirrie and Sir John Biles, on the economic size and speed of steamers, and on the development of harbors from the point of view of ship-owners and builders. It is stated that the effect of the deepening of the Suez Canal and of the capacity of the Panama Canal on the development of harbors, will be the building of vessels of the maximum dimensions, capable of passing through the canals, and a resultant demand for an increase in the depth of harbors. He states that the minimum depth now desired for a first-class harbor is 40 feet, and suggests that, in view of the time required to obtain results, engineers should recommend 45 feet.

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CONTENTS OF THIS ISSUE.

ESTIMATE vs. TENDER ON CIVIC WORK OPEN TO CONTRACT.

The practice of a city engineering department competing with contractors on public works is beneficial in that it acts as a preventative against a possible agreement among contractors in the matter of prices or conditions of work. It also acts as a stimulus to the engineering staff. This factor is important, as shown in last week's issue, in connection with some remarks on the much-discussed subject of contract versus day labor in municipal work. Obviously such competitive tendering saves money by keeping the staff more efficient and by keeping low the price of general construction work.

But in few cities is the engineering department so well developed that it can better carry out such work (with the exception, perhaps, of extensions to water mains, sewers, pavements, etc.) and at a lower cost than the responsible contractors who bid for it are invariably in a position to do. The situation is almost always the reverse. Questions of plant, labor, and experience are in favor of the contractor, and the city engineer is at a disadvantage, too, owing to inelasticity of organization. The question then arises as to the advisability of a tender from the city engineering department on work to which the above conditions apply. If it be the lowest it ought to be accepted under this competitive plan. But if the engineer's tender is to be used merely for purposes of comparison, is not the some object attained by his submitting an estimate?

The value of a city engineer's cost record of day-labor work is often questioned by contractors, and perhaps rightly so. It does not always contain such items as overhead charges, light, office rent, insurance, etc. In addition it is claimed that the engineer has many opportunities for so distributing his charges as to make the final cost of a particular work amount to any figure he desires, within a reasonable latitude.

Providing the city engineer completes the work at a figure under the bid, he may not lay claim to the profits, nor may he lay aside a part or all of such profits to cover the cost of maintenance during a guarantee period; despite the fact that the competing contractors included in their bids an estimate of maintenance for this period—an amount varying with the traffic, up to ⅓ or more of the actual cost, and properly a maintenance charge.

Again, if the work costs more than the engineer's tender the corporation pays for it, and the result is an overexpenditure of the by-law providing the funds for the Local Improvement. This occasions complaints of mismanagement from ratepayers. But, if the contractor underestimates the cost of his work, the contract price holds good, and he is the loser.

There appear to be many important works, concerning which an estimate, conscientiously worked out by the engineer, answers the same purpose as a competitive tender, and leaves to contractors the tendering for work which they are better equipped to do than is the city engineering department. Naturally, the discontinuance of tendering on all such work would not be advisable as the beneficial effect in the matter of stimulus to the engineering staff would be offset. But, a judicious combination of the two would tend to lessen the arduousness and responsibility and to add to the efficiency of the city engineer's department, without losing the advantage of being able to check contract prices.

PUBLIC TALK ON WATER SUPPLY.

A course of open lectures is being given by Dr. T. A. Starkey at McGill University, Montreal, on the principles of public health. His lecture last week dealt with surface waters, as found in brooks, rivers and lakes, pointing out the difficulty of protecting such sources from pollution. He explained in a thoroughly non-technical way the processes of purification and disinfection, claiming both as necessary factors in a community bordering on water that has any connection with a source of supply. The danger in the use of untreated waters even by municipalities where the supply is collected upon high levels and is, therefore, generally pure and admittedly suitable for domestic use, was instanced by two examples. One was a lake of very pure water which was polluted from a farmhouse, causing 400 cases of typhoid in a town of some 10,000 inhabitants. Another was the well-known case of the town of Plymouth, on the Susquehanna River, where a single typhoid case infected the water supply and caused 1,500 cases, many fatal, in a population of 8,000 or 9,000. Contamination was too lightly thought of in many of our localities.

Dr. Starkey emphasized the fact that there were well-established processes of filtration and disinfection, for the complete removal of bacteria. In the matter of sewage disposal, also, the effluent could be so treated that it would be devoid of offensive properties. Concerning filtration, he described the slow sand and rapid mechanical types of filters as to their construction and mode of operation. He fully explained the important function of the coagulant in the efficient removal of bacteria.

Chlorination was recommended to be used only in emergency cases and not as permanent practice. In such disinfection the necessity of careful regulation was advanced, as the chlorine was disposed to attack whatever other organic matter the water might contain before acting upon the bacteria. It was essential that the mixing should be thorough to avoid patchy disinfection. The process was liable to seriously impair the supply as to taste and smell, as well as to effect the skin of the user.

The outstanding features of Dr. Starkey's lecture are mentioned to show the value of lectures of this nature to the general public. As a work that should be taken up in every city and town its importance cannot be overestimated. The findings of the International Waterways Commission, in the matter of pollution of boundary waters will soon be officially made public. As Canada becomes more thickly populated the waters will carry greater volumes of impurities. Every effort should be made to acquaint the public that the serious side of the water supply question is that pertaining to healthfulness. The practice of drawing raw supply from above the municipality and emptying untreated sewage below it must be discontinued. Progress in the right direction is too slow, but it is largely because there is a general lack of knowledge of conditions and of familiarity with the available means of remedying them.

EDITORIAL COMMENT.

An amendment carried in the Quebec Legislature recently altering the paving law of Montreal to the effect that the majority vote of the whole city council, rather than the board of control, will now decide whether the property owners are to pay a share of the cost of street pavements.

LETTER TO THE EDITOR.

Sir,—My attention has been directed to the various articles upon fixed carbon which have appeared in your magazine, and also the discussion of these articles given by Mr. Law in your issue of January 15th.

In summing up the points brought out in this discussion, it appears that the main objection to the fixed carbon test is based upon the difficulty of obtaining concordant results in various laboratories, and to the uncertainty regarding the values determined on this account. Also, it is urged that the test has no real significance, and is of no scientific value. It is further urged by several writers that the fixed carbon test has been stolen from fuel chemistry and is consequently objectionable and discreditable.

The statement given by Mr. Law, with reference to the first argument is admittedly true, and the results indicated by him as obtained from various laboratories are quite interesting, but not illuminating without information as to the manipulation employed. This objection, however, is well made, but it is not a valid one if there is any intrinsic merit in the test. As pointed out by Mr. Pullar, various other tests made in connection with the paving industry are subject to similar variation in the hands of different operators, and the consistent elimination of all such tests which do give variable results, would leave very little of value in the technical routine of asphalt examination.The writer, for example, has observed analyses of the same sample of asphalt by equally reputable operators in which the penetration at 32° F. has varied 25 per cent.; at 77° F., 20 per cent.; volatilization loss varying 100 per cent., and penetration loss 112 per cent. Yet these same chemists in different cities checked each other on fixed carbon determinations within one-tenth of one per cent. Again, variations in ductility tests exceeding 30% have been observed under like conditions. Surely, Mr. Law's reasoning is equally applicable to the above tests, and if he is correct, all of these should be discarded and discredited without further question. The contention along these lines indicates rather the necessity for more closely standardizing the method of making fixed carbon tests rather than the necessity for its elimination. While this has been done by the Committee on Coal Analysis of the American Chemical Society, even their procedure requires more careful description and standardization of details than is given. Aside from this, the writer has observed on many occasions that even the standard method is not followed, or is very loosely followed by chemists making fixed carbon determinations, and in this connection, the method quoted by Mr. Law is a very pertinent example of the looseness of manipulation which tends to give these variable results.

An instance has come under the writer's observation in which this disregard of standard procedure has gone so far as to include the use of a porcelain crucible, with, needless to say, correspondingly curious results. It would therefore seem reasonable to advocate primarily that the test be more closely standardized before its elimination on this account be held desirable.

With reference to the significance of the test, the writer has attempted, in a preceding article, to determine just what it indicates—and the practical observations of Mr. Pullar are quite in line with those of the writer, and in accord with the experimental data presented in the article referred to. If this data is correct,

it is apparent that the test has some significance if uniform results can be obtained, and if such results are properly interpreted. On the other hand, if the data be not correct, it will appear that the test is useless. So far, the opponents of the test have brought forward no proof as to its significance, but have confined themselves to unsupported statements in this direction.

Reference to the origin of this test in the fuel industry as an argument against its application in the asphalt industry, is hardly worthy of discussion. Many tests are used in one industry which may be perfectly properly employed in another, and the general application of the above reasoning to the field of analytical chemistry in general, would serve to indicate the unreasonableness of this contention. This does not merit further discussion.

While those who favor the retention of a fixed carbon requirement admit the necessity of closer standardization, their position is based upon the belief that the test, when properly applied, has merit. This necessity for standardization applies not only to the fixed carbon test, but to other tests of recognized merit, which, as pointed out by Mr. Pullar, give variable results. Assuming, then, that the test will be capable of closer standardization, the question arises as to how the requirement is to be incorporated into specifications in such a manner as to prove effective, and at the same time fair to the producer and consumer. This means that requirements should not only admit good materials, but should uphold a standard which will bar from equal competition, those materials which are of lesser quality than the highest grade. This should not resolve itself into a matter of opening wide the specifications in the effort to modify the requirements to meet any certain product.

The suggestion of Mr. Pullar, with reference to different limits for various classes of asphalts is objectionable in creating arbitrary distinctions, and is fully open to the criticism brought by Mr. Law, involving dangerous precedent, and is a step in the direction of complicating rather than simplifying the basis of quality competition. The suggestion of the writer in the previous article based upon a formula involving the character of crude and percentage of yield, was given as a scientific statement of the requirement verified by laboratory research, which would obviate the necessity of classifying these materials or establishing a maximum fixed carbon limit, and would likewise provide the necessary variation for various consistencies. As stated in this article, the application of the requirement given, involves knowledge of the two above factors, fixed carbon in crude and yield of asphalt, for effective application. Mr. Law objects to this requirement on the ground that the inspecting chemist will be without means of verification of these factors. This, of course, does not follow when the material is subject to refinery inspection. Under such conditions these factors will be readily obtained by the inspecting chemist. As previously stated, difficulties arise when no refinery inspection is maintained, for it becomes necessary for the chemist to obtain his data on laboratory runs of the crude from which the product in question is made. Possibly a laboratory run will not exactly represent manufacturing figures, and it is not necessary that it should, for if carefully carried out, such trial does give the minimum theoretical fixed carbon value characteristic of a given penetration under ideal refining conditions. This statement is made as the result of many trials and comparisons. In view of the above, the variations in manufacturing figures become immaterial under the same method of operation.

It is admitted that in the absence of refinery inspection this latter operation can only establish standards for a given product made uniformly from the same crude. As indicated previously, this method is subject to the ability of the inspecting chemist to obtain, in the laboratory, the data necessary. While it is perfectly feasible to obtain this in the manner described, there are still some objections which might be properly urged. In examining a large number of samples, such as are often submitted with bids, the work of preparing fixed carbon standards for a number of different materials would be particularly laborious. Again, the determination of quality, based upon anything but the character of the finished product is not in accord with the most progressive ideas in specifications. The introduction of the clause referred to, would sift itself down to the judgment of the engineer or inspecting chemist as to his ability or his facilities for effective application of a requirement based upon these conditions. This applies only in the absence of refinery inspection, for, where the material is inspected at the plant, the writer can see no other reasonable objection to the suggested requirement.

The following alternative clause is suggested which is more readily capable of application. It does not possess, however, the scientific basis, nor can it take into account the necessary variation of fixed carbon with consistency, as does the previous requirement. As here stated, it would apply generally to paving cements of the usual consistency.

"The asphaltic cement considered apart from its native non-bituminous matter, shall be soluble in cold carbon tetra chloride to the extent of 98.5%, and shall yield upon ignition not more than 13% of fixed carbon, unless the solubility in the above solvent is increased by .2% over 98.5% for each one per cent. of fixed carbon in excess of 13%."

This, in reality, embraces two requirements which ordinarily are written separately. If the engineer or chemist has no faith in the carbon tetra chloride test (which is another much discussed question), this solvent might be replaced by carbon disulphide or any other solvent which he might consider effective in indicating the products of decomposition.

The theory of the above requirement is that products normally high in fixed carbon due to the nature of the crude, when properly prepared, will contain no insoluble matter. In effect, it places the burden of proof on these products by requiring them to show freedom from those insoluble constituents which may result from the conditions before mentioned. Likewise, materials prepared from low fixed carbon crudes will be limited to lower figures, more nearly normal than has usually been heretofore considered acceptable.

The above is suggested as an alternative to the requirement outlined in the previous article, and is given with a view of placing upon a reasonably equal basis all materials prepared from both low and high fixed carbon crudes. Either requirement in a specification retains, for the use of the inspecting chemist, a test which, when properly applied and interpreted, is quick to determine relative qualities in materials of the respective class referred to.

L. KIRSCHBRAUN.

Chicago, Ill., January 17th, 1914.

CANADIAN SOCIETY OF CIVIL ENGINEERS

ABSTRACT OF REPORT OF COUNCIL FOR THE YEAR 1913—TWENTY-EIGHT HUNDRED MEMBERS ON ROLL — TENDENCY TOWARD PROGRESSIVE WORK REFLECTED BY REPORT — FINANCIAL POSITION GOOD

The Council presents the following report on the work of the Society during the past year:

ROLL OF THE SOCIETY.

The elections took place as follows:—Thirty Members, fifty-four Associate Members, one Associate, forty-five Juniors and one hundred and thirty-five Students.

Twenty-six Associate Members were transferred to the class of Member, eleven Juniors were transferred to the class of Associate Member, one hundred and twenty Students were transferred to the class of Associate Member, eighty-three Students were transferred to the class of Junior and two Students to the class of Associate.

Seventeen deaths have been reported: one Honorary Member, nine Members, three Associate Members, one Junior and three Students. There have been removed from the rolls by resignation and on account of non-payment of dues, or on account of failure to apply for transfer to an appropriate grade: Three Members, five Associate Members, one Associate, one Junior and four hundred and thirty-seven Students.

At present the membership stands as follows:—

Hon. Members	12
Members	622
Associate Members	1,313
Associates	40
Juniors	262
Students	545
Total	2,794

The large number of Students noted above as having been removed was the outcome of the circular issued in January, 1913, calling attention to the limitations of Student membership and notifying all concerned that unless application were made for transfer to a higher grade their names would be removed from the rolls.

The seventeen members who have been removed from the rolls of the Society by death are the following:—

Hon. Member	Sir William H. White, K.C.B., F.R.S.
Members	P. Alex. Peterson (Past President)
	Peter S. Archibald (Member of Council)
	Adolphus Bonzano
	Alfred Brittain
	George Blinn Francis
	Albert George Macfarlane
	James Ross
	Wilfrid Theodore Skaife
	William Johnston Sproule
Associate Members	Edward Jodoin
	Lambert Lynn
	Russell D. Willson
Junior	James Melville Robertson
Students	Norman Wesley Brownell
	Harold Franklin Cole
	Paul E. Poitras

The resignations in practically all cases have been due to the fact that the gentlemen in question have ceased to be actively engaged in engineering work.

ANNUAL MEETING.

The twenty-seventh Annual Meeting was held at 413 Dorchester Street West, Montreal, in January, 1913, under the presidency of Mr. W. F. Tye.

The first session was called to order on Tuesday, January 28th, at 10.30 a.m., and the meeting was adjourned on Thursday afternoon, January 30th.

MEETINGS.

The Council has held seventeen meetings during the year. There have been four sectional meetings and seven monthly meetings of the Society.

The following papers and addresses were presented:

Monthly Meetings:

"Street and Railway Track Paving with Asphalt Block in a Suburban Town," by Mr. Frank Chappell, A.M.Can.Soc.C.E.

"Trusses without Diagonals in Reinforced Concrete," by Mr. V. J. Elmont, A.M.Can.Soc.C.E.

"The Projection and Survey of the 141st Meridian Boundary Line," by Mr. D. H. Nelles, A.M.Can.Soc.C.E.

"Results of an Investigation by the Dominion Government on the Coals of Canada from an Economic Standpoint," by Dr. J. B. Porter, M.Can.Soc.C.E.

"Elevator Construction," by Mr. Jas. Spelman, M.Can.Soc.C.E.

"The Toronto Water Filtration Plant," by Mr. F. F. Longley, A.M.Can.Soc.C.E.

"The Engineering Problem of Electrification," by Mr. A. H. Armstrong, M.Am.Inst.E.E.

Electrical Section:

"Electrification of a Reversing Mill at the Algoma Steel Company," by Mr. B. T. McCormick, A.M.Can.Soc.C.E. (Joint Meeting of Electrical and Mechanical Sections.)

"The Use of Synchronous Condensers with Transmission Lines," by Mr. H. B. Dwight, A.M.Can.Soc.C.E.

Mechanical Section:

"Present Practice in Design and Construction of Hydraulic Turbines," by Mr. H. B. Taylor, M.Am.Soc.M.E.

Mining Section:

"The Outlook for Mining in British Columbia," by Mr. C. E. Cartwright, M.Can.Soc.C.E.

"Initial Proceedings in Opening up a Coal Mine," by Mr. C. M. Odell, M.Can.Soc.C.E.

BRANCH SOCIETIES.

The several Branches of the Society, their Headquarters and Officers at this date are as follows:—

Victoria —Headquarters, 534 Broughton Street., (Address P.O. Box 1290.)
Chairman, F. C. Gamble.
Sec.-Treas., R. W. Macintyre.

Vancouver—Headquarters, McGill University College.
Chairman, G. R. G. Conway.
Sec.-Treas., J. R. Grant.

Calgary —Headquarters. (Address Drawer V.)
Chairman, H. B. Muckleston.
Sec.-Treas., P. M. Sauder.

Manitoba —Headquarters, University of Manitoba, Winnipeg.
Chairman, E. E. Brydone-Jack.
Sec.-Treas., G. E. Bell.

Toronto —Headquarters, Engineers' Club, King St. West.
Chairman, E. A. James.
Sec.-Treas., A. B. Garrow.

Kingston —Headquarters, School of Mines.
Chairman, A. K. Kirkpatrick.
Sec.-Treas., L. W. Gill.

Ottawa —Headquarters, 177 Sparks Street.
Chairman, G. A. Mountain.
Sec.-Treas., A. B. Lambe.

Quebec —Headquarters, City Hall.
Chairman, A. R. Decary.
Sec.-Treas., A. Amos.

COMMITTEES.

The following have been the Committees of Council during the year:—

Library and House Committee:

F. P. Shearwood, Chairman. R. J. Durley.
J. M. Robertson. H. R. Safford. A. Stansfield.

Finance Committee:

C. N. Monsarrat, Chairman. G. H. Duggan.
W. J. Francis. H. Holgate. E. Marceau.

The Czowski Medal Committee:

G. A. Mountain, Chairman. E. E. Brydone-Jack.
W. J. Stewart. A. E. Doucet. J. Galbraith.

OFFICERS OF SECTIONS.

General:

C. N. Monsarrat, Chairman. W. J. Francis, Vice-Chairman.

Electrical:

R. M. Wilson, Chairman. J. C. Smith, Vice-Chairman.

Mechanical:

H. H. Vaughan, Chairman. H. M. Jaquays, Vice-Chairman.

Mining:

J. B. Porter, Chairman. H. P. DePencier, Vice-Chairman.

Committee on Publications:

G. H. Duggan, Chairman. R. J. Durley, Secretary.
H. P. DePencier. J. M. R. Fairbairn. L. A. Herdt.

Committee on Meetings:

C. N. Monsarrat, Chairman.

The officers of Sections together with the Chairman and Vice-Chairman of Branches.

The Board of Examiners for admission of candidates under by-laws 8 and 9 is as follows:—

H. M. MacKay, Chairman. A. Surveyer, Secretary.
R. S. Lea. H. M. Jaquays. H. P. DePencier.
A. M. Gray. P. E. Mercier. J. Flahault.
M. Beullac.

The following have been the Committees of the Society during the year:—

The Nominating Committee for Officers and Members of Council for the year 1914:

H. M. Jaquays, Chairman, representing District No. 1.
H. N. Ruttan,
C. H. Rust, } Past Presidents.
W. F. Tye,
F. W. W. Doane, representing District No. 2.
F. X. A. Leofred, " " " 3.
Jas. White, " " " 4.
J. G. Sing, " " " 5.
W. L. MacKenzie, " " " 6.
L. G. Robinson, " " " 7.

Cement Specifications:

J. A. Jamieson, Chairman. C. H. Rust.
D. MacPherson. C. E. W. Dodwell. W. P. Anderson.
F. P. Gutelius. J. S. Dennis. H. Holgate.

Improved Engineering Service:

H. Holgate, Chairman. A. W. Campbell.
J. A. Jamieson. F. L. Wanklyn. G. J. Desbarats.
A. St. Laurent. L. A. Vallee. H. J. Lamb.

Establishment of Testing Laboratories:

C. H. Keefer, Chairman. J. Galbraith.
H. M. MacKay. Phelps Johnson. J. A. Jamieson.
P. Gillespie. G. E. Perley. J. B. McRae.

Educational Requirements:

E. Marceau, Chairman.
W. F. Tye. J. B. Porter. R. W. Leonard.
H. Irwin. H. Holgate.

Sewage Disposal:

John Kennedy. W. Chipman. R. S. Lea.

Steel Bridge Specifications:

C. N. Monsarrat, Chairman. F. P. Shearwood.
J. G. Legrand. R. F. Uniacke. G. H. Duggan.
N. M. McLeod. H. G. Kelley. W. A. Bowden.
P. B. Motley. F. C. McMath.

Conservation:

James White, Chairman. C. R. Coutlee.
H. F. Laurence. R. McColl. R. O. Sweezey.
W. H. Breithaupt. G. A. Bayne. A. J. MacPherson.
J. S. Dennis. J. B. Hegan. C. E. W. Dodwell.
A. E. Doucet. R. S. Lea. R. W. Leonard.
E. E. Brydone-Jack. W. R. W. Parsons. John Chalmers.
T. H. Tracy. J. B. Challies. C. H. Mitchell.
Wm. McNab.

The Electro-Technical Commission:

L. A. Herdt, Chairman. O. Higman.
H. T. Barnes. L. W. Gill. W. A. Duff.
L. A. Rosebrugh. J. Kynoch. J. Murphy.
A. B. Lambe.

Rails:

H. G. Kelley, Chairman. G. A. Mountain.
J. M. R. Fairbairn.

Track, including the subjects of Fastenings, Tie Plates and Ties:

H. R. Safford, Chairman. A. C. Mackenzie.
F. P. Gutelius.

Reinforced Concrete:

W. J. Francis, Chairman. P. M. Morssen.
C. N. Monsarrat. H. M. MacKay. P. B. Motley.
E. Brown. S. Baulne. E. S. Mattice.
E. Brydone-Jack. J. Galbraith. H. Rolph.
P. Gillespie.

The awards of the Gzowski Medal and of prizes for the best students' papers will, in accordance with the practice of previous years, be announced during the meeting.

The following is a statement of elections which have taken place since the issue of Bulletin No. 9:

October 14th, 1913.

Members:

Anderson, W.	Bligh, W. G.	Duffield, H. J.
Groves, F. W.	Kimball, H. S.	Larner, C. W.
Matheson, E. G.	McCormick, R. S.	Pearce, W.
Richardson, W. F.	Swinnerton, R. W.	

Associate Members:

Begg, J. McG.	Brown, P. P.	Clemenston, N. E.
Corman, W. E.	Garbi, L., Jr.	Herren, P. H.
Joncas, J. P. P.	McLay, D. B.	Mitchell, A. K.
Perry, K. M.	Preston, F. M.	Rodger, W.
Shannon, J.	Soper, D.	Talbot-Crosbie, W. H.
Thrupp, E. C.	Wilson, J. A. G.	

Associate:

Wilson, G. R. J.

Juniors:

Broderick, C. A.	Coumans, O. F.	French, M. H.
Gibault, J. E.	Langelier, J. N.	Maltby, Q. J.
Poitras, E.	Shaw, J. B.	Worthington, A. N.

Transferred from Associate Member to Member:

Allaire, A.	Campbell, D. McD.	Haddin, J.
MacPherson, F. L.	Murphy, J.	Powell, G. G.
Rinfret, R.	Roy, R. M.	Young, C. R.

Transferred from Junior to Associate Member:

Holdcroft, J. B.	Lount, C. T.	Pequegnat, M.
Pringle, J. F.	Vallee, I. E.	

Transferred from Student to Associate Member:

Ballantyne, T. B.	Barbault, D. R.	Beach, F. K.
Beique, P. A.	Bertrand, J. E.	Brown, T. W.
Cameron, H. D.	Chevalier, P.	Copp, W. P.
Cowen, R. P.	Dunkley, J. B.	Goedike, F. B.
Hall, N. M.	Hay, N. K.	Henry, R. A. C.
Linton, A. P.	McConkey, T. C.	McMahon, J. W.
Melsted, V. J.	Mudge, R.	Powell, W. H.
Richardson, C. E.	Simard, J. W.	Smith, A. W.
Trimingham, J. H.	Waddell, N. E.	Webb, C. E.
Whitton, C. F.		

Transferred from Student to Associate:

Robertson, G. S.

Transferred from Student to Junior:

Arsenault, A.	Bacon, T. H.	Belanger, J. C.
Bell-Irving, D. P.	Brickenden, F. M.	
de Cardaillac, R. E. M. G.		Carman, H. V. St. J.
Cole, F. T.	Cowley, F. P. V.	Duggan, H. S.
Lamb, S. R.	Lapointe, E.	Lee, R. B.
MacKinnon, K. R.	McKnight, R. C.	Middleton, J. R.
Millican, A. G.	Nares, B. L.	Neilson, L. R.
Plamondon, J. A.	Spencer, R. A.	Stewart, A. D.
Street, J. C.	Tessier, J. des R.	Tooker, G. L.
Whittaker, D.		

November 11th, 1913.

Member:

Junkins, S. E.

Associate Members:

Booth, P. D. Lee, C. A. Murton, J. C.

Junior:

McLellan, R. A.

Transferred from Associate Member to Member:

Lea, W. S.

Transferred from Junior to Associate Member:

Hogarth, G. Rider, E. B.

Transferred from Student to Associate Member:

Brown, J. A.	James, E. W. McD.	Macauley, R. M.
MacDonald, J. J.	MacLennan, G. G.	

Transferred from Student to Junior:

Burnett, G. K.	Day, H. S.	Scott, O. H.
Shanks, G. L.	Wilson, LeR.	

December 9th, 1913.

Associate Members:

Busfield, J. L. Greig, J. M. M.

Juniors:

Hetherington, W. B.	Kohl, G. H.	Macrae, L. P.
Morrisey, H. F.		

Transferred from Associate Member to Member:

Angus, W. F.

Transferred from Student to Associate Member:

Benedict, E. McL.

Transferred from Student to Junior:

Dinsmore, F. L. Fraser, R. J.

GENERAL.

The Council, having appointed the officers and standing committees for the year, at once entered upon the work of carrying out the instructions of the Annual Meeting.

The various national engineering societies were communicated with and the terms upon which their publications could be procured were ascertained and the information promptly forwarded to the Branches.

The commitment *re* appointment of Committees reporting to the Society was dealt with as follows:—

The Annual Meeting re-appointed the Committees on Establishment of Testing Laboratories, Educational Requirements, International Electro-Technical Commission, Conservation and Bridge Specifications.

It was decided that it was not necessary to re-appoint the Committee on Good Roads; and the Committees on Railway Ties, Roadbed and Ballasting and on Railway Fastenings and Tie Plates were re-organized under two Committees to be called a Committee on Rails and a Committee on Track.

It was also resolved to discontinue the Committee on Transportation Routes and to memorialize the Government as to the formation of a permanent Commission. This memorial is attached hereto. In connection with this matter, Messrs. W. F. Tye, C. R. Coutlee and J. A. Jamieson were requested to contribute such information as they had collected in regard to transportation routes as papers for the Transactions of the Society.

The two Committees on Sewage Disposal and the Special Committee on the same subject have been consolidated.

Having considered the proposal to appoint a Committee on Specifications for Steel Water Pipes, it was decided that it was not desirable to name such a Committee at the present time, but that the subject should be kept before the Society by means of a paper to be read at one of its meetings. Mr. F. H. Pitcher was requested to prepare such a paper.

After conference with various members of the Society engaged in concrete construction, a Committee was appointed to draw up a specification on the subject of reinforced concrete under the Chairmanship of Mr. Walter J. Francis, Member of Council. This Committee will present a report to the Annual Meeting.

The Specifications on Roadbed and Ballasting and on Steel Railway Bridges of Fixed Spans, approved at the last Annual Meeting, have been printed and distributed to members of the Society. The Society's specifications which have now been printed and are at the disposal of the engineering profession in Canada are the following:—Portland Cement, Cast Iron Water Pipe and Special Castings, Roadbed and Ballasting, and Steel Railway Bridges of Fixed Spans.

The opinion of the Society's solicitors was sought as to the conditions under which the Society, or a Branch of the Society, could be incorporated in British Columbia. The substance of the opinion was to the effect that a body capable of exercising general supervision over matters of interest to the profession in British Columbia, consisting of members whose relations to this Society should remain unaltered, could be established under legislative enactment.

In this connection the Vancouver and Victoria Branches were requested to definitely formulate the action they desired the Council to take and to outline such amendments to the Society's by-laws as they considered necessary in relation to the subject.

The Victoria and Vancouver Branches, replying to the communication of the Council, submitted the following recommendations:—

(1) That the parent Society will authorize the formation of a British Columbia Section of the Canadian Society of Civil Engineers; the said Branch to be governed by the existing Charter and By-Laws, and further amendments thereto of the parent Society.

(2) That the British Columbia Section shall include all members of the Canadian Society of Civil Engineers residing in this Province.

(3) That the British Columbia Section will be granted power to report on all British Columbia applicants for admission to the Society.

(4) That no candidate living in British Columbia will be admitted without the consent of the Executive of the British Columbia Section.

(5) That the Executive of the British Columbia Section will be given permission to collect rebates of annual fees from all members of the Society in this Province, and expend the sum thus realized in connection with the expenses of the Section, paying over a just proportion thereof to the Vancouver and Victoria Branches respectively, and in the future to any other Branch that may be hereafter formed in the Province.

(6) That the Executive of the British Columbia Section will be given power to discipline members living in British Columbia.

In consideration of these recommendations the Council, at a meeting held on August 6th, resolved that Sections or Divisions of the Society might be formed on the request of a majority of the Branches in Any Province; that the existing by-laws in regard to Branches should not be changed.

except that it should be possible for any member residing outside the 25 mile limit to join a Branch and become liable for the fees payable as a Branch member, the usual portion thereof to be remitted to the Branch.

It was not considered necessary that any financial arrangements should be made under the by-laws for the upkeep of the Provincial Divisions but that they should provide for their own operating expenses.

It was further agreed that recommendations Nos. 4 and 6 were not admissible; that in regard to recommendation No. 5 all dues must continue to be paid directly to Headquarters as heretofore, rebates being made to the Branches.

The matter was referred to a Committee of Council to draft a statement for revision of the by-laws in accordance with these findings, and it was decided in pursuance of the suggestion of the Annual Meeting to call a special meeting of Council for September 20th at which to consider the necessary amendments to by-laws in connection with the foregoing and in other directions. It was further arranged that the railway, sleeping car fares and all actual expenses while on the train should be paid to non-resident members attending the meeting. Members of Council residing in cities in which there are Branches of the Society were requested to get in touch with Branches and to represent the views of members to the Council in time for consideration at the September meeting.

The special meeting referred to was attended by the following Members of Council:—Mr. Phelps Johnson, President, in the Chair; Mr. W. F. Tye, Past President; Messrs. F. C. Gamble and H. H. Vaughan, Vice-Presidents; and Messrs. W. D. Baillairgé, E. Marceau, J. C. Kennedy, C. N. Monsarrat, C. H. Duggan, J. M. R. Fairbairn, R. J. Durley, A. F. Stewart, F. A. Bowman, H. E. T. Haultain, W. J. Francis, S. J. Chapleau and the Secretary. Two sessions were held and the proposals in regard to amendments to by-laws now before the membership were approved.

At a subsequent meeting of Council the proposals of the B.C. members, which are now also before the membership, were received and it was considered desirable to issue the circular letter attached to the proposed amendments to by-laws in explanation of them.

The place of holding the Annual Meeting has this year received more than usual attention in view of the fact that the British Columbia Branches extended a cordial invitation to the Society to hold the meeting in Victoria. The opinion of the membership was sought, and as a result of the postal card notice sent out some 700 replies were received, indicating a majority in favor of the meeting in British Columbia. Resolutions regarding the place of meeting were received from some of the Branches and expressions of opinion from non-resident Councillors and other members of the Society.

After a very full consideration the following resolution was adopted:—

> "That in view of the strong desire expressed by many of the members and Branches of the Society to hold a meeting in British Columbia in 1915, on account of the Panama Exposition to be held at that time and the opening of two transcontinental lines, and considering the impossibility of holding a meeting on the Pacific Coast in two successive years, it was decided that the meeting of 1914 should be held in Montreal."

This decision of the Council has been approved by the Executive of the Victoria Branch.

The Council desires to call the attention of the Meeting to the fact that the by-laws of the Society do not specify the place of holding the Annual Meeting, and suggests the desirability of an amendment in that regard.

The importance of holding meetings in the various cities of Canada is fully recognized and the Council, having given some thought to the subject, is of opinion that these meetings should take the form of a Summer Convention, the annual business meeting of the Society being held at Headquarters.

In the opinion of Council it would be well that the practice of holding one meeting of Council during the year, at which members from all parts of Canada could be present, should be established, and possibly such gathering might occur in connection with a summer convention.

In furtherance of the resolution adopted by the Annual Meeting regarding stream measurements, Mr. James White, Assistant to the Chairman of the Commission on Conservation, was asked to gather together all results of measurements made under the direction of the Dominion and Provincial Governments and to have the same published under the auspices of the Commission. Mr. White was kind enough to undertake this work should time permit.

The matter of improving the library facilities was undertaken in connection with the Library Committee with the result announced in the report of that Committee.

The Council has pleasure in reporting that in accordance with the suggestion of the last Annual Meeting a Junior Section of the Society has been formed. This Section has held several meetings during the year. Its officers at present are as follows:—

A. J. Kelly, Chairman.	W. Clerk.
J. H. Norris.	B. O. Smith.
R. M. Walker.	

The Council reports the appointment of Mr. H. G. Kelley to fill the vacancy created by the death of Mr. J. M. Shanly at the close of the year 1912.

The vacancy created by the death of Mr. P. S. Archibald, which occurred on March 16th last, was not filled.

The Society has been represented at various gatherings during the year, amongst which may be noted the ceremony in connection with the placing of the window in Westminster Abbey in memory of the late Lord Kelvin, which ceremony was attended by Mr. W. F. Tye, Past President of the Society. Mr. H. J. Bowman represented the Society at an International Road Congress in London, of which the Society has now become a member. The Society was also represented at the Western Canadian Irrigation Convention by Messrs. H. B. Muckleston, F. H. Peters and P. M. Sauder.

The Council desires to call the attention of members to the importance of a more general response to the request accompanying the preliminary notice of applicants for admission and transfer—viz., that members are invited to report any facts which may affect the classification and election of any of the candidates and, where the professional career of applicants is known, they are specially invited to make a definite recommendation as to classification. It is regretted that this invitation has not been generally accepted and that as a result classifications have been made which have subsequently given rise to criticism.

The financial statement presented herewith shows the total cost of the Society's building, which it is satisfactory to note is within the appropriation for the purpose and substantially in accord with the report made to the Society last year.

The Council desires to record its satisfaction at the interchange of courtesies through the Ottawa Branch with the American Society of Civil Engineers at its Convention in Ottawa in June last. This Convention was attended by a number of members of the Society who appreciated the hospitalities extended by their Ottawa brethren and the officers and members of the American Society of Civil Engineers.

Attention is called to the fact that a Branch of the Society has been established in Calgary under the Chairmanship of Mr. H. B. Muckleston. The branches of the Society now number eight, in accordance with the list published on another page.

The attention of Council has been called to the establishment, or proposed establishment, of a Society of Municipal Engineers in Regina, and it has been reported that this Society proposes to seek exclusive legislation from the several Provincial Governments. The matter is being investigated by the Council.

Two volumes of *Transactions* were published and distributed during the year—namely, Volume II. for 1912 and Volume I. for 1913. Bulletin No. 9, giving lists of members elected between the date of the last Annual Meeting and July 1st, additions to the Library and general notes of the Society's affairs, was issued during the month of August.

The Council regrets that up to this date it has not been possible to obtain reports from all of the Committees for submission to the membership. Such reports as were in hand at the end of the year have been printed for distribution in advance of the Annual Meeting.

Acting on a suggestion at the Annual Meeting, the Council has, as already noted, made the attached representations to the Dominion Government with reference to the problem of transportation routes.

PHELPS JOHNSON, President.
C. H. McLEOD, Secretary.

Montreal, January 14th, 1914.

Your Memorialists have the honor to submit for the consideration of the Government of Canada, that the time is now opportune to appoint a Royal Commission on Transportation and allied problems.

The early opening of the Panama Canal and the great development in all lines of industry from one end of Canada to the other, raise questions demanding the most careful solution.

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(1) The report of the Transportation Commission made in 1908 contains a great deal of valuable data, but is now largely obsolete.

(2) That such a Commission should consist of seven members—viz., one Railway Engineer, one Hydraulic Engineer, one Railway Manager, a Lawyer, a Transportation Manager familiar with Lake and Ocean Navigation, two eminent business men, one from the East, one from the West, and a secretary.

(3) That such report should include and, whenever possible, make recommendation on the following matters:—

(a) Water Routes.—River improvement, lake and gulf dealing with existing systems—proposed systems from the commercial and engineering sides, harbors, docks, graving docks, types of ships and barges for inland service.

(b) Winter and Other Ports.—National and local, required facilities and equipment having regard to the handling of grain, merchandise, manufactures, coal and the other heavy bulk products to the end that the most economical method be secured.

(4) There is a necessity for an even, steady movement of traffic throughout the year. How may this be accomplished at the least possible cost to the people of Canada?

(5) The water power possibilities, as an incident of navigation on the St. Lawrence, Ottawa, and other important rivers. It is believed by competent men that the St. Lawrence may be converted into slack water navigation from Montreal to Lake Ontario by the building of about five dams and five ship canal locks, and that as an incident thereto, several million horsepower of energy may be had at very low cost. Such a possibility suggests a development in manufacturing of incalculable value to the country and would seem worthy of special report.

The existing canal system on the St. Lawrence is expensive to maintain and operate. The suggested system would seem to offer an opportunity for large savings in both respects.

(6) Railways:—

(a) Existing Railways.—In what respect is it possible to improve, having regard to terminals, receiving and delivering freight in large cities and at other important points? How may transportation be rendered more economical?

(b) What should be the policy of the country regarding new railways? What conditions should be made on behalf of the public?

(c) Earnings and Expenses.—A reasonable definition of what they should be.

(d) Competition.—To what end can it be secured?

(e) Regulation.—To what extent should it extend in order that capital may be secured for the continued requirements of the country and the public be sufficiently protected?

(7) Routes and Outlets:—

The Atlantic Seaboard.
The Pacific Seaboard.
The Hudson Bay.
The Great Lakes

(8) Your Memorialists, the Canadian Society of Civil Engineers, represent practically every qualified engineer in Canada. It is with a knowledge of the importance of the subject and of how easily great mistakes, causing enormous waste of money, can be made, that your Memorialists have approached the subject, in the hope that your honorable body may see fit to grant such a Royal Commission to the end that our common country may be benefited.

(Signed) PHELPS JOHNSON, President.
C. H. McLEOD, Secretary.

Montreal, December 1, 1913

REPORT OF THE LIBRARY AND HOUSE COMMITTEE.

The Library Committee reported on January 10th, 1914, that they had experienced a most progressive year. Additions to the reading matter had been very extensive in the endeavor to bring it up to date in all sections. The new volumes were carefully chosen or approved by the Chairmen of the different sections and the list was supplemented by members of the Committee. The purchase of the new Encyclopædia Britannica was recommended to the incoming Council. The thanks of the Society were said to be especially due to Mrs. P. A. Peterson, who had kindly presented to the Library many volumes of engineering works which belonged to the late Mr. P. A. Peterson, Past President of the Society.

This Committee superintended the moving and setting in order of the library in its new quarters, which occasioned very extensive labor; also the furnishing of the storage and reading rooms of the new building. The Committee, of which F. P. Shearwood was Chairman, recommended some further additions to the furnishing of the rooms.

STATEMENT OF FINANCES.

The receipts of the Society for the year ending 31st December, 1913, were $646.05 in excess of the expenditures. The expenditures amounted to $21,860.85, of which $2,120.50 was on account of rebating fees to branch societies, over $6,400 on account of printing, and about $1,700 interest paid on mortgages, etc.

The receipts, which amounted to $22,506.90, were made up mainly from fees collected, which amounted to $21,386.69.

The balance sheet shows a healthy condition, the Society owning the property at 176 Mansfield Street, Montreal, valued at over $91,500, including furniture. The Society also possesses a special bank deposit receipt for $5,000, and nearly $300 other cash on hand, $6,000 worth of books, and various other assets.

The liabilities consist mainly of a $20,000 mortgage on the property, less than $4,000 being payable on account of rebates to branches, prize fund accounts, accounts payable, etc.

Special credit is due for this good financial report to the Finance Committee of Council, the Secretary of the Society and to Mr. Ernest Marceau, who has been the efficient Treasurer of the Society for the past five years.

REPORT OF BOARD OF EXAMINERS.

January 6th, 1914.

Examinations were held in May and November. The results are summarized in the following table:—

Subject.	Number of candidates presenting themselves.	Passed.	Failed.
Theory and Practice of Engineering	11	6	5
Railway Engineering	10	7	3
Municipal Engineering	5	5	0
Total	26	18	8

The candidates rejected were, as a rule, so deficient in a knowledge of the principles underlying sound engineering practice that it was impossible to regard them as qualified to "design as well as direct engineering works." The admission of such candidates, probable enough in the absence of examinations, would in the opinion of the Board tend to lower the standing of the Society.

The Board also examined and passed upon a large number of educational certificates presented by candidates claiming exemption in whole or in part from the scheduled examinations. As these certificates emanate from a great variety of institutions, their consistent appraisal is difficult. The Board has also felt somewhat embarrassed by the lack of clear definition of its duties as compared with those of the Education Committee in respect to this work. It is felt that in order to secure the best results, the examination of certificates should be in the hands of a single body preferably distinct from the Examining Board.

ARTHUR SURVEYER, Secretary.
H. M. MACKAY, Chairman.

REPORT OF COMMITTEE ON ESTABLISHMENT OF TESTING LABORATORIES.

Ottawa, Ont., Jan. 13th, 1914.

The President and Members,
Canadian Society of Civil Engineers.

Gentlemen,—

I beg to submit the following report of the Committee on Establishment of Testing Laboratories, on behalf of the Members of our Committee: Professor J. Galbraith, Past President; Professor H. M. Mackay, Professor Peter Gillespie, and Messrs. Phelps Johnson, President; J. A. Jamieson, A. St. Laurent, Geo. E. Perley, J. B. McRae, and C. H. Keefer.

As the establishment of a Government Testing Laboratory is in the hands of the Government there is little that we have been able to do, except to urge its necessity both for the Government and the public.

The Minister of Public Works, the Hon. Robert Rogers, has been interviewed and written to, and asked to place an appropriation in the estimates for testing laboratories. I wrote him, for the Committee, that the definite information acquired through testing laboratories for the use of all the Government Departments interested in Canadian structural materials would be of great practical as well as scientific value, and that should the Government follow the example in this respect of other countries, it could not fail to ultimately add to Canadian prestige in keeping abreast of the times. In answer to this letter the Hon. Robert Rogers writes, "I will be glad to do whatever I can in the matter to which you refer."

The Deputy Minister of Public Works has also been interviewed and expressed himself in sympathy with our recommendations.

Our Committee recommends that, as the establishment of a Government testing laboratory is a matter depending solely on the action the Government may see fit to take, this Committee might for the present be discontinued; but we would also strongly recommend, should this action be taken, that the Council should keep the matter before the Government by writing frequently to the Minister of Public Works, drawing attention to the importance to the country, as well as the Government, of a laboratory such as they alone would be in a position to equip and maintain, and when definite action is taken by the Government that a Committee be again appointed to assist the Government in any way desirable, should they wish the co-operation of our National Society.

Respectfully submitted,
C. H. KEEFER,
Chairman.

A proposal to give Chicago a comprehensive subway system, costing from $80,000,000 to $150,000,000, to be paid for out of the earnings of the system, has been made to the Mayor, and a committee of the Chicago City Council by Walston H. Brown, engineer of New York and J. Morton Griffiths of Griffiths and Company, London, England.

Blast furnace operators, representing practically the entire merchant pig iron industry of the United States met in New York, on January 8, and organized the American Pig Iron Association. The membership, it was announced, comprises owners of plants with a property investment of $200,000,000, and an aggregate annual capacity of 13,639,000 tons of pig iron. The discussion of manufacturing problems, the standardization of pig iron grades, the reduction of costs and the improvement of quality are among the purposes of the organization, according to the by-laws adopted.

Final designs for the lamp standards, brackets and reflectors to be used in lighting the locks of the Panama Canal have been made and have received the approval of the Fine Arts Commission. The posts, including the ornamental ball, will be of reinforced concrete, cast in iron forms, and a total of 511 standards carrying single or double arm brackets will be required. The reflectors will be placed 29 feet 6 inches above the ground, and 4 feet 3 inches from the centre of the standard. Each concrete double arm bracket with reflectors will weigh approximately 1610 lbs.; and the solid ball, weighing 730 lbs., will be used to counterbalance the weight of the single arm brackets on the middle locks.

COAST TO COAST.

Calgary, Alta.—The receipts of the Calgary electric department for 1913 were $675,000, and the expenditures, $610,000, including interest on debentures, providing for sinking fund and special depreciation.

Winnipeg, Man.—The earnings of the Winnipeg Electric Railway on actual street car operation in the city of Winnipeg for the calendar year, 1913, were $2,384,597.28, an increase of $269,604.48 over the earnings in 1912.

Banff, Alta.—It has been stated by Engineer Child, of Banff, that estimates for the expenditure of $1,000,000 in public improvements at this city during this year have been prepared, and the work is to commence in the spring.

Winnipeg, Man.—Net earnings of the city light and power company for the month of December, reached a total of $88,752.73 after making allowances for corrections and discounts, showing a net and certain profit of $23,757.

Ottawa, Ont.—The annual report of the Transcontinental Railway Commission, produced in the Dominion House of Parliament, on January 22, showed a total expenditure of $126,000,000. The amount spent last year was $14,000,000; in 1912, $20,000,000. The New Brunswick section was under operation during the year, and produced a revenue of $32,000. The cost of operation of this section was $36,000.

Winnipeg, Man.—The statement of the light and power department of Winnipeg for 1913 reports that the peak load was increased from 14,000 to 20,000 horsepower; that the gross revenue was $850,000, the cash receipts $735,000; and in general that there has been a substantial increase in the installations of transformers, meters, lamps of all kinds and ornamental lighting, as well as in the erection of poles and the stringing of wire. The balance sheet will not be submitted until the end of the fiscal year, but Manager Glassco reports that the operations for the calendar year show a large surplus over all expenditures.

Iona, N.S.—About 1½ miles from Iona Station on the line of the Intercolonial Railway, and on the shores of the Bras d'Or Lakes, will commence at once the construction of a $50,000 calcining plant for the Iona Gypsum Company. The gypsum deposit of the company is estimated to contain 25,000,000 tons of 98 per cent. plaster rock, which will be reduced and mixed on the spot, and will be shipped from the company's wharf adjacent to the property. The quarrying is all cliff face open cut. The mill will be 60 x 40; and the warehouse and mixer 60 x 40. The power house is to be 32 x 40 and fitted with a twin battery of Robb Mumford boilers and a 225 horsepower compound Corliss engine.

Port Arthur, Ont.—Early last summer was commenced the construction of Port Arthur's new intake and pumping station, which is situated about a mile from Bare Point on the shore of the bay. The new pump house is completed and will soon be equipped with machinery, titanic pumps which will take up practically the whole height of the building. For the depth of 12 feet or more the structure has been built with reinforced concrete, while the remainder is of brick. The intake well machinery will not be installed until the tunnelling has been completed; and of the 1,500 feet of length to be completed, 300 feet have now been bored. This has been accomplished by blasting through solid rock. It is expected that this part of the work will be rushed and that it will be completed about the end of April; and also, that the entire undertaking will be finished and the plant put in operation by the first of July.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

CONTENTS.

BOOK REVIEWS.

Sewer Design.—By H. N. Ogden, C.E., Professor of Sanitary Engineering, Cornell University. Published by John Wiley & Sons, New York; selling agents for Canada, Renouf Publishing Company, Montreal. 248 pages; 71 illustrations; 5 plates; size, 8vo.; cloth. Price, $2.00 net.

Reviewed by Prof. P. Gillespie.

The second edition of Ogden's "Sewer Design," like its predecessor of fifteen years ago, is essentially a text-book. The title, the reader is compelled to feel, is something of a misnomer, since much of the matter contained in the volume has to do with sewer design *per se*, indirectly rather than directly. The much-discussed matters of rainfall and run-off are treated with considerable patience and detail, while many authorities and investigators are drawn upon in the preparation of the chapters relating thereto.

The chapter on sewer cross-sections comprises some six pages only, leaving with the reader the impression that this quite important phase of the designer's problem is altogether too briefly treated. The chapter on flushing is timely, and is illustrated by a number of half-tone and zinc etchings of flush-tanks and automatic siphons, taken mainly from the descriptive literature concerning these, issued by the manufacturers. The theory of the siphon is too brief, although, indeed, this seems to be a just criticism of most modern texts on this subject. Excellent features of the book from the student's viewpoint are the working out of specific problems from actual data and the incorporation of the rules and regulations for the preparation and submission of plans for sewerage systems and disposal works, New York State Department of Health, 1912.

Electric Power Plant Engineering.—By J. Weingreen. Published by McGraw-Hill Book Company, New York. 445 pages; 309 illustrations; 15 tables; cloth; size, 6 x 9 in. Price, $5.00 net.

Reviewed by H. G. Acres,
Hydraulic Engineer, Hydro-Electric Power Commission of Ontario.

The chapters, twenty-seven in all, have the following titles: Introductory; Direct-Current Generators; Synchronous Converters; Mercury Rectifiers; Storage Batteries; Three-Wire System; Feeder Panels; Direct-Current Motors; Direct-Current Circuit-Breakers; Direct-Current Stations; Typical Electric Power Stations; Low-Tension Switching; High-Tension Switching Arrangements and Methods of Connection; Circuit Interrupting Devices; Oil Switches; Relays; Potential Regulators; Constant-Current Systems; Starting Compensators; Lightning Arresters; High-Tension Switchboards and Wiring Diagram; Cells and Compartments; Wall Outlets; Central Stations; Typical Central Stations; Substations; Typical Substations; Appendix with fifteen tables.

The scope and purpose of the book is set forth in the preface as follows: "Its object is to offer to the contractor and engineer, as well as to the student, material which will help them to understand the methods of handling electrical energy. It is assumed that the reader is familiar with the basic principles of electrical engineering, as well as with electrical machinery and ordinary instruments. The aim has been throughout to restrict theoretical discussions as much as possible and to eliminate higher mathematics. The book is intended as a useful handbook for those concerned with practical problems."

The work has been limited to American power station engineering. The material represents exclusively present-day practice, and the lines which future development may be expected to follow are pointed out.

Chapters I. to X. are devoted to direct, and the remaining seventeen chapters to alternating current, the matter being so arranged as to give special prominence to the discussion of switch-gear and control apparatus in general. The direct-current section of the book takes up the first 94 pages only. This is directly the result of limiting the scope of the work to American station practice, for in no country in the world has the development of A.C. machinery and apparatus so overshadowed that of direct current as in America.

Chapter IV. on Mercury Rectifiers is interesting, as is also Chapter V. on Storage Batteries, the latter in particular containing valuable information relative to storage battery practice in Europe.

It is to be regretted that the author did not extend the scope of the direct-current section sufficiently to include at least a general description and discussion of the Theory system of direct-current high-tension transmission, concerning which very little has been published in this country up to the present time.

The alternating current section is mainly descriptive, with much tabulated matter, amply illustrated with plates, diagrams and reproductions of dimensioned drawings. The chapters on Oil Switches, Potential Regulators and Lightning Arresters are strictly up-to-date, and constitute the most important feature of the book.

The author has adhered strictly to the intention expressed in his preface with regard to the elimination of mathematical discussion, the book being intensely practical throughout. On this account a certain amount of first-hand, practical experience is necessary for a proper appreciation of its contents. While it, therefore, lacks the theoretical element usually called for in a student's text-book, it should have a wide range of usefulness as a reference book for practising engineers and plant superintendents.

Theory of Machines and Practical Mechanisms.—By Prof. Andrew Jamieson, M. Inst. C.E. Eighth edition of Vol. V. of series on Applied Mechanics and Mechanical Engineering. Publishers, Charles Griffin & Company, Limited, London, Eng. 526 pages; illustrated; cloth; size, 6 x 9 in. Price, $2.00.

Reviewed by A. S. L. Barnes,
Hydro-Electric Power Commission of Ontario.

Among English engineers the name of Andrew Jamieson, quondam professor of engineering in the Glasgow Technical College, is as a household word, and, were the present work in only its first edition, it would be taken for granted that it was well written; an eighth edition of such a book must, therefore, speak for itself.

Intended primarily for the use of students, and of engineers qualifying for various diplomas, the book is arranged in the form of lectures, which lead the reader from loci and point paths to numerous mechanical motions, efficiency of machines, gearing, etc.

The lecture on loci and others up to lecture No. 5 describe very clearly how the position of any point, or series of points, may be definitely indicated by referring them to fixed co-ordinates, and passes on very naturally to a consideration of different types of mechanical motions and the methods of ascertaining the paths described by different points in such mechanisms in various positions.

It would hardly be thought that the word "machine" was a difficult one to define, but the author refers to another writer, who quotes as many as seventeen different definitions, to which someone else has added several more. Prof. Jamieson states that the modern theory of machines would give the following definition: "To transform natural energy into particular kinds of work by a combination of resistant bodies, whose relative motions are completely constrained." This certainly looks scientifically correct, though, no doubt, the average man would be content with something more on the lines of the schoolboy's definition of salt, viz., that "it makes potatoes taste nasty when you don't put it in."

The middle portion of the book is devoted to mechanisms applied to divers kinds of machines, such as planing and shaping machines, winches, cranes, etc., and a good deal of space is given up to the design and methods of cutting the teeth of wheels; this latter subject is very fully and clearly dealt with

The transmission of power by belting and ropes comes next in order, while the latter portion of the book discusses the inertia of moving parts of engines, crank effort diagrams and various types of engine governors.

Each of the 18 lectures is supplemented by a number of suitable questions, and the closing pages of the book contain 4 Appendices, giving the examination papers set within recent years by a number of British educational and engineering bodies, definitions of the fundamental C. G. S. Units and their mechanical and electrical derivatives; and, finally, tables of logarithms and the trigonometric functions of angles.

Not only students, but trained engineers will find this book useful if the scope of their work covers the subjects with which it deals.

Handbook for Machine Designers and Draftsmen.—By Fred. A. Halsey, B.M.E. Published by McGraw-Hill Book Company, New York City. 494 pages; illustrated; size, 9 x 12 in.; flexible leather binding. Price, $5.00 net.

Reviewed by Prof. R. W. Angus,
Department of Mechanical Engineering, University of Toronto.

The author of this book was editor of the "American Machinist" for many years, and is, therefore, competent to discuss the very important matter of machine design. His book is intended for designers and draftsmen, and, therefore, contains a very great number of tables and diagrams so as to facilitate the draftsman's work, and to save time that would otherwise be required for calculations. There are also a great number of illustrations, although the author does not appear to have considered it essential to provide an undue number of drawings of machine parts.

Almost every part of the machine has been treated in the thirty-nine sectional headings, which include such a variety of subjects as bearings, belts, flywheels, gears, brakes, bolts and nuts, balancing, boilers, engines, etc. In the arrangement of the book the usual division into chapters has been replaced by a division into sections, each beginning on a new page, and each having the numbering of tables, diagrams, formulas and cuts starting at that section, so that it will be a fairly easy matter in future to add to the work.

To give the reader an idea of the contents of the book the section on hydraulics and hydraulic machinery has been selected at random and contains the following material in addition to other matter: Diagram of the velocity of water jet and horse-power corresponding to different heads, tables of capacities of tanks, loss of head in pipes, water delivered by hydraulic rams, diagrams of pipe-flow, loss of head in fittings, thickness of hydraulic cylinders and of rams, and of the power and capacity of pumps. The section also contains many useful formulas, data on hydraulic packings and cup leathers, information on friction in stuffing boxes, and numerous illustrations of parts of machines. It is evident that the treatment is fairly complete.

The designer and draftsman will find the book of very great help, but it is very unfortunate that it could not have been made in more convenient size, as it is a book which must lie on the drafting table and in its present form it takes up considerable space and is awkward to handle.

Suspension Bridges and Cantilevers: Their Economic Proportions and Limiting Spans.—By D. B. Steinman, C.E., Ph.D., Professor of Civil Engineering at the University of Idaho. Second edition, revised. New York: D. Van Nostrand Company (Science Series). Boards; size, 3¾ x 6 in.; 185 pages; four folding plates. Price, 50 cents.

Reviewed by C. R. Young, M. Can. Soc. C.E.,
Assistant Professor of Structural Engineering in the University of Toronto.

The first edition of Professor Steinman's little book, which appeared two years ago, was welcomed as one of the clearest economic studies of long-span bridge construction which had ever been written. So carefully and thoroughly had the author done his work that in the second edition, which now appears, it was not found necessary to modify the analytical studies of the structures considered nor the results of the investigations for their economic proportions and limiting spans.

Although the original edition of the book was thoroughly reviewed in this journal, it is perhaps desirable to briefly state the principal results of Professor Steinman's studies. In order to give a reliable basis for generalizations he has designed suspension bridges of 1,500, 2,250 and 3,000 feet and cantilever bridges of 1,000, 1,500 and 2,000 feet in span, respectively. Estimates of quantities and costs are submitted, and from these and other data it is concluded that (1) the maximum practical span for suspension bridges ranges from 3,500 to 4,900 feet, depending upon the assumed live load; (2) the limiting economic span for suspension bridges is about 3,170 feet; (3) the maximum practical span for the cantilever type ranges from about 2,000 to 3,000 feet, depending upon the assumed live load; (4) the greatest span

for which the cantilever type may be profitably employed is about 2,700 feet; (5) the span of equal cost for the types is 1,670 feet.

Few changes are made in the revised edition, and these are principally in furtherance of greater clearness. The term "limiting span" is introduced as signifying the span length which each type of bridge cannot physically exceed. The longest span at which the cross-section of the principal members will not exceed an assigned maximum value, determined by the limitations of design, fabrication, transportation and erection, is then termed the "maximum span." Added usefulness is conferred on the book by bringing the bibliographies up to date and amplifying the tables of bridges noteworthy for length of span or other features of interest. Four folding plates, showing the elevations and cross-sections of suspension bridges and cantilevers from 1,000 to 3,000 feet have been inserted illustrating the designs described in the text.

The excellence of this little book should commend it to anyone having to do with the design of long-span bridges.

Reinforced Concrete Construction—Vol. II., Retaining Walls and Buildings.—By George A. Hool, S.B., Associate Professor of Structural Engineering, the University of Wisconsin. Drawings by Frank C. Thiessen, B.S., Instructor in Structural Engineering, the University of Wisconsin. New York: McGraw-Hill Book Company, Inc. 666 pages; 411 illustrations in the text and 34 full-page and folding plates; cloth; size, 6 x 9 in. Price. $5.00 net.

Reviewed by C. R. Young, M. Can. Soc. C.E.

The excellence of the previous text-books prepared for use in the Extension Division of the University of Wisconsin is fully maintained in the second volume of Professor Hool's treatise on Reinforced Concrete Construction. Although the presentation has evidently been adapted to the needs of those students who must largely depend upon their own resources, the work can scarcely be said to lose value to the practising engineer on this account. So much practical information is contained in the six hundred odd pages that a little over-elaboration of a point is easily overlooked.

The book is divided into two parts, the first dealing with retaining walls, and the second with buildings. Of the 666 pages, however, 602 pages deal with buildings, a proportion to which no exception can be taken.

Retaining walls are covered in three chapters, dealing with the theory of stability, design and construction. Little space is given to the first and third divisions of the subject, the students' problem being assumed, as it would appear from the text, to be largely centred about design. In calculating the external forces on walls, the author employs the method of equivalent fluid pressure, undoubtedly a simple method of dealing with the problem.

Under buildings, floors are given first consideration. Monolithic beam and girder construction is exhibited very thoroughly, as far as design is concerned, by a detailed design of a typical floor panel in four different ways. Full-page plates containing details of these various schemes are given, even each reinforcing rod being fully detailed. Another panel is then designed, in one-way hollow tile construction, affording an instructive comparison with the monolithic type. The flat slab system, while perhaps not given the attention which Mr. Turner might desire, is nevertheless clearly described, as far as essentials are concerned. The author is not impressed with the accuracy of Grashof's analysis, and prefers the beam method or the circular plate method. Unit construction is deservedly given some space, followed by a discussion of various details and floor attachments. Chapter V. is devoted to types of reinforcement.

Following the discussion of floors, come excellent chapters on Roofs, Columns, Foundations, Walls and Partitions and Stairs. Valuable though the information in the chapter on Elevator Shafts may be, from the fact that it chiefly concerns elevators, it appears to be somewhat out of place in a text-book on reinforced concrete construction. One of the most valuable portions of the work is that dealing with continuous beams, eccentricity of loading on columns and wind stresses. Particularly with respect to the former, the fullness of detail, characteristic of the author's method, is likely to be appreciated.

The general discussion of structural elements is then effectively illustrated by two examples of the design of entire buildings. These examples are not in detail, portions of one of the buildings having previously been discussed minutely, but the general considerations and the specifications cited are particularly useful to the designer who has previously confined his attention to parts rather than the whole.

Proceeding to construction, Materials, Forms, Bending and Placing of Reinforcements, Proportioning, Mixing and Placing of Concrete, Finishing of Surfaces and Waterproofing are adequately considered. Mr. A. W. Ransome contributes an authoritative chapter on Construction Plant, and Mr. Leslie H. Allen, of the Aberthaw Construction Company, a most useful section on Estimating. The work is concluded by the inclusion in an Appendix of the Second Report of the Joint Committee on Concrete and Reinforced Concrete.

Considered in its entirety, there is little which can be criticized in the book. It appears to be fairly free from typographical and other errors, although the reviewer might point out that the strength requirements for cement and mortar on page 444 are erroneously given as pounds per square foot instead of pounds per square inch. Broadly judged, therefore, the book must be regarded as a most useful contribution to the literature of reinforced concrete.

Cement, Concrete and Bricks.—By Alfred B. Searles, Lecturer on Brickmaking under Cantor Bequest, Consulting Ceramic Engineer, Sheffield, England. Published by Constable & Company, Limited, Leicester Square, W.C., London. 412 pages; size, 6 x 9 in.; cloth. Price, $3.00.

This book is one of a series of text-books introductory to the chemistry of the national industries, and, therefore, deals in detail with the chemistry of the materials mentioned in the title. It is descriptive rather than technical, and it is a collection of facts rather than an exposition of any new theorem. The illustrations and examples are English, and are, therefore, not as convincing to Canadians.

There are four distinct divisions in the book, the first of which deals with cements, commencing with a chapter on the raw materials and concluding with a descriptive chapter of the usual tests. The second division is called concrete, and is, like the part on cement, laboriously thorough in descriptive detail. The lines of stress in beams are shown in carefully prepared illustrations, but no mention is made of the rules which govern the shape, length, height or breadth of it. Reinforcing systems are illustrated, but nothing is said about the disposition of the steel; so that this part is not of technical value. The three chapters on bricks are the most interesting and instructive in the book, although they are not to be considered as a text on the subject. The fourth division, which consists of five pages, and which seems to have been added as an appendix, does not deal with siliceous bricks as fully as the subject deserves.

The book is well written and well indexed, making it convenient as a reference. It may be considered as a summary of the facts regarding cement, concrete and bricks without proofs or rules.

The Sampling and Assay of Precious Metals.—By Ernest A. Smith, Assoc. R. S. M. Deputy Assay Master, Sheffield Assay Office. Published by Charles Griffin & Company, London. 460 pages; 166 illustrations; size, 6 x 9 in.; cloth. Price, $4.50.

This book is an effort at a comprehensive treatment of the whole subject, and one cannot claim that the author has not succeeded in producing a work that will be well looked upon by the student and the adept in the practice of assaying. The various methods of sampling and of assaying ores, bullion and alloys of gold, silver, platinum, and the metals of the platinum group, are fully described. The author as deputy master of the Sheffield (Eng.) assay office, has a clear conception of the importance of accuracy in sampling and assaying operations. His book bristles throughout with the indication of the happy faculty of acquiring knowledge of the essentials and of imparting it in a practical way.

There are 25 chapters, the first five of which deal with the design and equipment of assay offices and the use of apparatus and appliances. Furnaces for the use of solid, gaseous and liquid fuel; balances and weights, and the art of weighing, etc., are included. The chapters on sampling are, in the writer's opinion, the most noteworthy of the book. A chapter on laboratory in a cyanide mill comprises a valuable 40 pages. The remaining chapters are devoted to assay work of the various metals.

It should be said that some of the sections are not so adequately dealt with as others, or as their importance would seem to warrant; but the value of the book lies more in the thoroughness which has accompanied the portion of what, in the author's mind, apparently stands out most prominently.

Another creditable feature of the work is its index. It is an admirable compilation, and adds materially to the degree to which the book will be found useful.

Reviewers frequently overlook the importance of advising prospective customers of the artisan construction of the book under discussion. The publishers have left no room for suggestions for improvements. The binding, paper, and printing are excellent, and the illustrations well proportioned. Taken altogether, the book should run into several editions.

PUBLICATIONS RECEIVED.

Ontario Agricultural and Experimental Union.—34th annual report (1912).

Victorian Institute of Engineers, Melbourne, Australia.—Vol. 12—1912 of the proceedings of the Institute. 254 pages; cloth binding; illustrated.

Canadian General Electric Company.—Presidential address of Mr. Frederic Nicholls, December 27th, 1913. Reprinted in the form of a 14-page booklet.

Library Catalogue.—Public Service Corporation of New Jersey. A 152-page catalogue of Authors and Titles of the Public Service Library of New Jersey.

Ontario Good Roads Association.—Proceedings of the 11th annual meeting, 1913, appended to the annual report of Mr. W. A. McLean, Provincial Engineer of Highways.

The Third International Road Congress.—A report by the Chief Engineer of the Board of Estimate and Apportionment of the City of New York upon the London Congress, June 23rd to 28th, 1913; 54 pages.

Municipal Lighting.—A report by special committee of the Municipal Lighting for South Hadley, Mass.; containing a report by Wm. Plattner, Consulting Engineer, 714 Old South Building, Boston, Mass.

Manufacture of Hollow Reinforced Concrete Poles, Piles and Pipe.—By R. M. Jones. A [illegible]-page illustrated description of the Jones process for the manufacture of hollow reinforced concrete poles, piles and pipe.

Department of Naval Service, Ottawa.—A report for year ending March 31st, 1913, including reports on the survey of tides and currents; hydrographic survey branch; radiotelegraph branch; Naval branch, etc. 128 pages, besides illustrations and maps.

The Meteorological Aspect of Smoke Problem.—By Mr. H. H. Kimball, Ph.D. Bulletin No. 5 of the Mellon Institute of Industrial Research in Pittsburg on Smoke Investigation. A 50-page pamphlet dealing with the general problem of the effect of smoke upon sunshine in large cities.

Wood-using Industries of New York.—The 28th bulletin of this character, which has been prepared by the Forest Service of the United States Department of Agriculture. A 215-page illustrated book, with numerous tables, showing the demand upon each Wood by each Industry.

Report on the Bureau of Supplies.—Department of Water, Gas and Electricity. City of New York. A 93-page report dealing with such phases of the Bureau, as scope, organization and administration, purchasing, inspecting, storage, records and issue, illustrated by photographs and colored charts.

Dangers to Workers from Dusts and Fumes and Methods of Protection.—Bulletin No. 127 of the United States Department of Labor, Bureau of Labor Statistics. Containing 62 plates exhibiting industrial machinery and appliances liable to endanger the health of the workers, and methods of remedy. This is No. 3 of a series on Industrial Accidents and Hygiene.

Problems of the Contractor.—By Leonard C. Wason, President of Aberthaw Construction Company, Boston, Mass. A 40-page booklet reprinted from the Journal of the Association of Engineering Societies for Nov. 19th, 1913; dealing with the relations between the contractor on one side, and the owner, engineer and the inspector, on the other, in the matter of building construction. Booklet sent free by the above company.

Report of the Transit Commissioner. City of Philadelphia. An exhaustive report in two volumes of the problem of improving the transit facilities of Philadelphia, containing definite recommendations, and plans for carrying them out, for a system of rapid, efficient and cheap transit throughout the city and suburbs. Vol. I. of 267 pages, contains sections devoted to a recommended rapid transit, its general design, estimates, traffic surveys, etc., and is well supplemented by tables, diagrams, etc. Vol. II. contains 69 maps and plans of systems in other cities, construction plan, time, time-distance, distance diagrams, etc. By Ford, Bacon and Davis, Consulting Engineers, and Mr. Merrit Taylor, Transit Commissioner.

PERSONAL.

W. J. MOORE, O.L.S., A.M.Can.Soc., C.E., has been appointed Town Engineer of Pembroke, Ontario.

G. P. COLE addressed a meeting of the Montreal Electrical Society last week on the subject of "Transformers."

C. H. MITCHELL, C.E., has been elected president of the Toronto Civic Guild, of which he has been vice-president for the past three years.

A. B. GARROW, B.A.Sc., assistant engineer, Main Drainage Department, city of Toronto, left last Friday for a few weeks holiday in Bermuda.

ERNEST A. RICHARDSON, City Commissioner of Saskatoon, has handed in his resignation, to take effect April

15th. Mr. Richardson will resume his former connection with the G. H. Archibald Construction Company of that city.

H. E. BALLANTYNE, B.A.Sc., a graduate of '93, School of Practical Science, and a prominent architect of New York City, addressed the University of Toronto Engineering Society recently on "The Architect and Engineer in Modern Architecture,"

J. B. CHALLIES, Superintendent, and J. T. Johnson, hydraulic engineer, were the representatives from the Water Power Branch Department of the Interior, at the recent session of the International Waterways Commission in Washington.

PAUL D. SARGENT, M.Am.Soc. C.E., Chief Engineer, State Highway Commission, Augusta, Me., on January 20th delivered an illustrated lecture on "Gravel and Its Use in Highway Construction" before the Graduate Students in Highway Engineering at Columbia University.

J. G. FETHERSTON is assistant designer in the engineering division of the Street Cleaning Department of the city of Toronto. Mr. Fetherston is a younger brother of Mr. John T. Fetherston, who was recently appointed Commissioner of Street Cleaning of New York City. Previous to coming to Toronto Mr. Fetherston had charge of the erection of an incinerator plant at Savannah, Ga.

J. E. JONES has accepted the position of mechanical engineer in the engineering division of the Street Cleaning and Refuse Department, city of Toronto. Mr. Jones was previously with the Electric Bond and Share Company of New York as chief designer. He has had considerable previous experience in hydro-electric and steam plant projects. Mr. Jones graduated from the School of Practical Science, Toronto, with the class of '94.

E. W. OLIVER, manager of construction, Canadian Northern Railway, Toronto, gave a talk, on Jan. 22nd, to the members of the Civil's Club of the University of Toronto, an organization among the civil engineering students of the third year in the Faculty of Applied Science and Engineering. Mr. Oliver dwelt upon the process of organization of railway companies, factors of location, supplies and construction procedure, and outlined the phases of railway work that presented opportunities for the civil engineer.

E. H. DRURY has returned to Canada from Chili, and has joined E. J. Walsh of Ottawa in the firm of Walsh and Drury, consulting engineers, Booth Building, Ottawa. Mr. Drury was general manager and chief engineer of the Longitudinal Railway of Chili, and had previously been connected with a number of other railways in Canada and Cuba, and also with the construction and operation of power houses in Canada and Mexico. Mr. Walsh has had a wide experience as engineer for various departments of the Dominion Government, in connection with a number of Canadian railroads, as chief engineer of Trent Canal surveys, in municipal engineering and in public works engineering in the West Indies for the Department of the Secretary of State for the Colonies.

OBITUARY.

The death is reported from British Columbia of Mr. JAS. D. SWORD, a prominent consulting mining engineer, and a resident of that province for over 20 years. Mr. Sword was widely known in Canada, Mexico and Colorado. He was actively associated with the Rossland and Kootenay activities in British Columbia in the earlier days. He was also associated with the founding of the Canadian Mining Institute. Death was due to accidental drowning while on a trip to record some assessment wórk on a mining claim.

ENGINEERING STAFF OF THE GREATER WINNIPEG WATER DISTRICT

The following engineers are those who are engaged on the Shoal Lake water supply project of the Greater Winnipeg Water District, of which W. G. CHACE, B.A.Sc., is chief engineer. (This scheme was discussed in *The Canadian Engineer*, Vol. 25, pp. 431 and 605, issues of September 11 and October 23, 1913.)

MAX V. SAUER is the Chief of Design in the Winnipeg office. He is a graduate of the University of Toronto, Faculty of Applied Science, 1902. Since taking his degree he served for two and one-half years in various capacities under Messrs. L. L. and P. N. Munn on the staff of the Ontario Power Company, Niagara Falls, Ont., having latterly been assistant to the mechanical engineer. For one year he was chief designer and had charge of transmission line structures on the staff of the Niagara Falls Power Company, being responsible there for the transmission line from the plant of the Canadian Niagara Power Company to Buffalo and for the Buffalo sub-station. The next year he spent as construction engineer for the Niagara, Lockport and Ontario Power Company in charge of their transmission lines between Niagara and Syracuse, N.Y. Since 1907, Mr. Sauer was first chief draughtsman, and then for four years, mechanical assistant and mechanical engineer for the Ontario Power Company. During this period, he served in a similar capacity on the design of the Salmon River Power Company's hydro-electric plant near Syracuse, N.Y.

GEORGE F. RICHAN.—A graduate of Acadia University, N.S., has been engaged nearly altogether in railway work, having begun with the New York and New England Railroad as rodman. He was engaged for 12 years in various capacities on the maintenance of way and on the construction staffs of the Boston and Albany Railroad, having amongst other duties that of locating engineer in charge of branch line work and on the re-location on the main line. His duties involved abolition of certain grade crossings and rearrangement of various railway services. He served throughout the entire period of preliminary and location surveys on the construction of the National Transcontinental Railway, having resigned after completing, in July, 1913, the duties of division engineer on Divisions Nos. 5 and 6.

ARCH PAGET.—Mr. Paget is also a railway man, having served from 1897 to 1908 in various capacities in the construction department of the western lines of the Canadian Pacific Railway. Since 1908 he has served in the employ of contractors as superintendent of construction and as engineer; and his last duty prior to joining the staff of the Greater Winnipeg Water District was the supervision of the double track work of the Canadian Pacific Railway on the Lake Superior division, district 3.

DOUGLAS L. McLEAN.—A graduate of McGill University in Civil Engineering, who won the British Association medal and prize in 1909. During his college course he served with railway engineers and with surveyors. Since graduation, he has been designer for Mr. J. B. McRae, consulting engineer of Ottawa, Ont., assistant chief engineer to the International Commission on the River St. John, and for two years has served the Water Power Branch of the Department of the Interior in explorations of the Winnipeg River, having latterly been chief engineer to the Manitoba Hydrographic Survey.

A. C. D. BLANCHARD.—A graduate of McGill University in Civil Engineering in 1901; was for five years assistant engineer and latterly construction engineer for the Canadian Niagara Power Company of Niagara Falls, Ont. He then served as engineer in charge of construction under Messrs. Ross and Holgate of Montreal in charge of the 32,000 horse-

power development of the West Kootenay Light, Heat and Power Company. He was then for four years assistant to the city engineer of Toronto, in charge of sewage disposal and intercepting sewers, gaining there both design and construction experience. From 1911 to 1913 Mr. Blanchard was city engineer of Lethbridge, Alta.

CHAS. J. BRUCE.—Received his engineering training in the field and in practice since 1903. He has served the Dominion Coal Company of Sydney, N.B., as chief mine surveyor for two years. He was for three years with the Dominion Government on the Trent Canal and for three years on the surveys and final location of the Hudson's Bay Railway.

Messrs. Richan, Paget, McLean, Blanchard and Bruce, are each in charge of a survey party in exploration and location of the aqueduct line.

The work to date has engaged the services of about 100 men, including engineers and their assistant labor. They have cross-sectioned and explored the country between Winnipeg and Indian Bay, all in Manitoba, and trial lines are being run for the aqueduct. Considerable success is being attained in effort to discover a uniform continuous down grade from Shoal Lake to Winnipeg, so that a gravity supply at minimum cost may be available in Winnipeg. The remainder of the winter will be required for completing studies of this problem.

A large staff has also been engaged in the office in the collating of field notes, in making the preliminary designs. Good progress can be reported in drafting of specifications for the preliminary stages of the work, as is evidenced by the fact that the Commission is already calling for tenders.

ANNUAL MEETING, TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

On Wednesday evening, January 21st, the annual meeting of the Toronto Branch of the Canadian Society of Civil Engineers was held in the lecture room of the Engineer's Club. Mr. E. A. James, chairman of the Branch, presided.

The treasurer's report, read by Mr. A. B. Garrow, secretary-treasurer of the Branch, showed a cash balance of $877.50, a large portion of which sum is to be expended forthwith in the enlargement of the already extensive library belonging to the Branch and open to its members in the library rooms of the Engineer's Club.

The election of officers for the coming year resulted in the unanimous selection of Mr. A. F. Stewart as chairman, and Mr. John S. Galbraith as secretary-treasurer. Messrs. J. G. G. Kerry, C. H. Mitchell and Prof. P. Gillespie were elected members of the executive committee. Mr. Kerry was also nominated as representative for District No. 5 of the nominating committee of the parent Society.

The proceedings of the evening included a discussion of the proposed extension to the library. It was generally felt that the members would derive much benefit from the compilation and publication of a comprehensive index, covering the libraries of the Toronto Branch of the Society, the Ontario Land Surveyors' Association, the Ontario Association of Architects and the Engineer's Club. A general lack of knowledge on the part of the members of the extent of the library and the books contained therein seemed to exist. Messrs. W. Chipman and T. C. Irving, Jun., made some valuable suggestions for the speedy carrying out of extensive library development. A library committee was appointed to investigate and recommend additions, this committee consisting of Prof. C. R. Young, and Messrs. A. L. Mudge and W. A. Hare.

Among those present were the following:—Members:—J. G. Kerry, A. F. Stewart, H. E. T. Haultain, J. G. Sing, Willis Chipman, A. R. Davis, C. H. Mitchell, C. R. Young, F. W. Thorold, G. A. McCarthy, J. R. W. Ambrose. Associate Members:—L. M. Arkley, F. B. Goldike, T. H. Hogg, E. T. Wilkie, J. Hutcheon, S. M. Oborn, J. M. M. Greig, Peter Gillespie, A. L. Mudge, W. A. Hare, T. R. Loudon, E. T. Brandon, W. A. Bucke, E. L. Cousins, E. R. Clarke, A W. Connor, E. A. James, A. B. Garrow, P. H. Mitchell, A. E. Jopp, P. W. Greene, T. C. Irving, Jr., O. L. Flanagan. Junior Members:—D. C. Blizard, C. C. Bothwell. Student Members:—R. P. Johnson, C. H. Fuller, D. H. Fleming, A. S. Miller, E. P. Muntz, John S. Galbraith.

CLAY WORKERS' ANNUAL MEETING.

The Canadian National Clay Products Association is in convention this week in Toronto. The following are among the speakers whose names appear on the programme of the meeting:—

Herbert N. Casson, Vice-President of H. K. McCann, New York; M. E. Gregory, President of the Brick Terra Cotta and Tile Company, Corning, N.Y., on "Commercial Side of the Clay Business"; Joseph Keele, Dominion Geological Survey; Prof. Edward Orton, Jun., Ohio State University, Columbus, Ohio, on "Ceramic Course"; Prof. Day, Ontario Agricultural College, Guelph; Prof. M. B. Baker of Queen's University, Kingston; A. F. Greaves-Walker, Ceramic Engineer with the Sun Brick Company, Toronto, on "Brickyard Kinks"; Miller Gibson, Ceramic Engineer, National Fireproofing Company, on "Different Types of Fireproofing, Their Manufacture and Burning"; John F. Wilde, Ceramic Engineer with E. H. Crandell Pressed Brick Company, Calgary, Alta., on "Types and Construction of Kiln Furnaces"; Dr. McKay, Principal of Toronto Technical School; D. O. McKinnon on "History of Our Association"; A. L. McCredie, on "Advertising Clay Products"; John Millar, Clayburn, B.C.

The Convention is being well attended and the gathering is quite representative of the ceramics industry of the Dominion.

COMING MEETINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Annual meeting will be held in Montreal, Que., January 27-29, 1914. Secretary, Prof. C. H. McLeod, 176 Mansfield Street, Montreal, Que.

CANADIAN CLAY PRODUCTS MANUFACTURERS' ASSOCIATION.—Annual Convention to be held at King Edward Hotel, Toronto, Jan. 27th, 28th, 29th, 30th. Secretary, J. R. Walsh, 40 Blake Street, Toronto.

WESTERN ONTARIO CLAY PRODUCTS ASSOCIATION.—Convention to be held in Chatham, Ont., February 4 and 5, 1914.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th, 1914. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN WATER WORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 State Street, Troy, N.Y.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21188—January 10—Authorizing V.V. & E. Ry. & Nav. Co. to construct spur for Campbell River Lumber Co., Ltd., near Crescent, B.C., to be constructed within six months from date of this Order.

21189—January 10—Authorizing C.N.R. & C.P.R. to operate trains over crossing in St. Boniface, Man., without first being brought to a stop.

21190—January 12—Authorizing C.N.R. to open for traffic revised line across Rainy Lake, Ont., from mileage 224.3 to 226.4, a distance of 2.1 miles.

21191—January 9—Approving location C.P.R. Swift Current Northwesterly Branch Line from a point in Sec. 20-28-6, W. 4 M., at mileage 169.0, thence in northwesterly direction to a point in Sec. 4-29-7, W. 4 M., mileage 175.0. Also authorizing the construction of said Branch across Seven (7) highways, mileages 169.10 to 174.61, Alberta.

21192—January 12—Authorizing C.P.R. to open for traffic third track from a point on north side of Queen St. subway, at Parkdale Station, to a point on south side of Royce Ave., at West Toronto, in City of Toronto, Ontario.

21193—January 10—Extending, until March 15th, 1914, time within which C.P.R. complete work of constructing additional track to present siding accommodation for use of Dodge Manufacturing Co., Ltd., at West Toronto.

21194—January 12—Authorizing G.T.R. to construct additional track across Inverness St., Village of Caledonia, Co. Haldimand, Ont.

21195—January 9—Authorizing G.T.P. Ry. to construct bridge across Endako River, at mileage 358 Prince Rupert East, B.C.

21196—January 10—Authorizing G.T.R. to reconstruct bridge No. 48 over Black Creek, at Mile Post 120.21 from Black Rock on 20th Dist., Tp. Downie, Co. Perth, Ontario.

21197—January 12—Authorizing Sandwich, Windsor and Amherstberg Ry. and Canada Southern Ry. to operate crossing of industrial spur of Canada Southern Ry. extending to plant of Postum Cereal Co., of Canada, Ltd., city of Windsor, Ont., on east side of Wellington Ave.; trains of Canada Southern Ry. and cars of Applicant Co. be brought to full stop before crossing diamond, and flagged over crossing by trainmen and conductors, respectively, in charge of said trains and cars.

21198—January 12—Authorizing G.T.P. Ry. to construct its main line across and divert 2 highways in B.C., mileage 461, Prince Rupert Easterly, Cariboo Dist., and mileage 357.3 Prince Rupert Easterly, in Stel-La-Qua Reserve, Rge. 5, Coast District.

21199—January 12—Authorizing C.P.R. to construct spur into premises of J. I. Case Threshing Machine Co., Regina, Sask.

21200—January 13—Authorizing C.P.R. to open for traffic portion of double track from mileage 67.7 to 76.8, Moose Jaw Sub. Div., Saskatchewan.

21201—January 13—Authorizing C.P.R. to operate over bridges at Guy, Aqueduct and Mountain Sts., Montreal, Que.

21202—January 13—Authorizing C.N.R. to construct across and divert public road in N.E. ¼ Sec. 14-28-9, W. 3 M., Sask., on its Delisle Branch.

[illegible]—January [illegible]—Authorizing C.P.R. to operate over bridge on Decarie Ave., city of Montreal, Que.

21204—January 13—Authorizing C.P.R. to construct its Weyburn-Stirling Branch Line across twenty (20) highways, Prov. Sask., mileage 299.145 to 316.765.

21205—January 14—Amending Order No. 21114, dated Dec. 30th, 1914, by striking out figures "165.95" wherever they occur in said Order, and inserting in lieu thereof figures "105.95."

21206—January 9—Approving revised location C.P.R. main linet, Lake Superior Div., Chapleau Sub. Div., as constructed from mileage 125.14 to 126.76 (mileage 127 old line), and from mileage 129.83 to 131.65 (mileage 132.27 old line), through Tps. No. 28, Gallagher, and Chapleau, Dist. Sudbury, Ont.

21207—January 9—Authorizing G.T.P. Ry. to construct bridge across Stoney Creek, mileage 397.1, Prince Rupert East, B.C.

21208—January 14—Authorizing, subject to terms of consent of village of Plessisville, G.T.R. to construct siding into premises of Plessisville Foundry Co., on Original Lot 171, Rge. 7, Tp. Somerset South, Co. Megantic, Que.

21209—January 14—Approving proposed Supplement No. 1 to C.N.R.'s Standard Freight Mileage Tariff for its Eastern Lines, C.R.C. No. E., 212: said Supplement, with copy of this Order, to be published in at least two consecutive weekly issues of "The Canada Gazette."

21210—January 15—Amending Order No. 18570, January 24th, 1913, by adding paragraph "2, that when road approaching crossing, mileage 38.90, is graded so that road along Tp. Line is passable, Co. put in crossing and diversion, if diversion is found necessary: detail plans be submitted for approval of Engineers of Board." Rescinding Order No. 19037, dated April 11th, 1913.

21211—January 15—Directing that C.P.R. remove station at Kruezburg, Man., from present location to a point on road allowance at east end of its yard.

21212—January 15—Approving revised location C.N.R., Con. 3, Tp. Halkirk, Dist. Rainy River, Ont., mileage 210.11 to 211.05.

21213—January 16—Authorizing Canada Southern Ry. and G.T.R. to use crossing of siding leading to Canadian Steel Foundries, Limited, Tp. Crowland, Co. Welland, Ont.; trains of both companies be brought to full stop before making crossing.

21214—January 12—Relieving C.P.R. from providing further protection at crossing of highway known as Cote du Sud, mileage 11, from Place Viger Station, Montreal, Ottawa, Sub. Div., Que.

21215—January 16—Authorizing C.P.R. to open for traffic portion of double track from Waldeck to Eaman, mileage 99.4 to 109.4, distance of 10 miles, Swift Current, Sub. Div., Sask.

21216—January 8—Amending Order No. 21026, Dec. 15th, 1913, by striking out paragraph 3 of said Order.

21217—January 16—Rescinding Order No. 19400, May 29th, 1913, in so far as it exempts C.N.Q.R. from fencing portion of right-of-way between mileages 23.5 to 34.

21218—January 16—Authorizing Can. Nor. Alta. Ry. to construct bridge across Stony River, Sec. 35-48-28, W. 5 M., Alta. Mileage 209.3.

21219—January 15—Authorizing G.T.R. to operate engines and cars over siding of Confederation Construction Co., Limited, on Lot 9, Con. 10, Tp. Grantham, Co. Lincoln, Ont., near Merritton.

21220—December 27—Directing G.T.R. to construct, at expense of W. J. Watson, Glencoe, Ont., farm crossing on Lot 9, Con. 2, Tp. Mosa, Ont., subject to certain conditions.

21221—January 16—Authorizing G.T.R. to construct extension of branch line, or siding, serving Empire Cotton Mills, Limited, at Welland, Ont., such extension being situate on Lot 24, Con. 5, Tp. Crowland, Co. Welland, Ont.

21222—January 16—Authorizing C.P.R. to construct, at grade, roadway in S.E. ¼ Sec. 19-12-29, W. 3 M., and roadway in N.W. ¼ Sec. 18-12-29, W. 3 M., at Cummings, Sask., across its main line tracks, Alta. Div., Medicine Hat Sub. Div.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

RAILWAY CROSS TIES

SUITABLE WOODS — NATURE OF MECHANICAL WEAR — PROTECTION — THE VALUE OF TIE PLATES — TYPES USED BY VARIOUS ROADS

By J. L. BUSFIELD, B.Sc., A.C.G.I., A.M. Can. Soc. C.E.

IN the construction and maintenance of a railway the cross tie is in itself an almost insignificant item, but when one considers the fact that the railways in Canada have to face an expenditure of over 10 million dollars per annum on ties alone, they have a bearing on the economics of railway management of much greater importance than would at first appear possible. This expenditure is one that is increasing every year. The statistics are not yet available for the year 1913, but the amount actually spent on ties by the steam and electric railways of Canada was $5,540,769 in 1911, and $9,373,869 in 1912, an increase of 69%, so that there is no doubt but that the figure for 1913 will be well over the $10,000,000 mark.

The causes of this large increase are many, but the most prominent are: (1) The larger number used; (2) increase of cost per tie; (3) increased use of the more expensive hardwood ties, and (4) the shorter life of ties. Analyzing these items separately, the first needs little comment as the increase is a natural one due to the growth of railway mileage; a small proportion of this item is also accounted for by item (4), namely, the shorter life of ties.

The increased cost per tie is mostly caused by the greater demand and diminishing supply. Some years ago the supply was so unlimited that practically no ties were imported into Canada, and the railways could obtain very nearly all they might require from points in close proximity to their own lines, thus reducing the cost of haulage. But in recent years the available supply has become reduced and localized so that the railways have had to import ties to quite a considerable extent, large quantities of southern hard pine being brought over 1,500 miles from Louisiana and Georgia. In 1912 the value of imported ties was approximately $1,700,000, or 20% of the total expenditure of Canadian railways on ties. The average cost per tie of all the ties used in 1911 was 39c., and in 1912, 44c., and with the prices prevalent during 1913 there is little doubt but that there will be a similar increase in the average price for the year just passed.

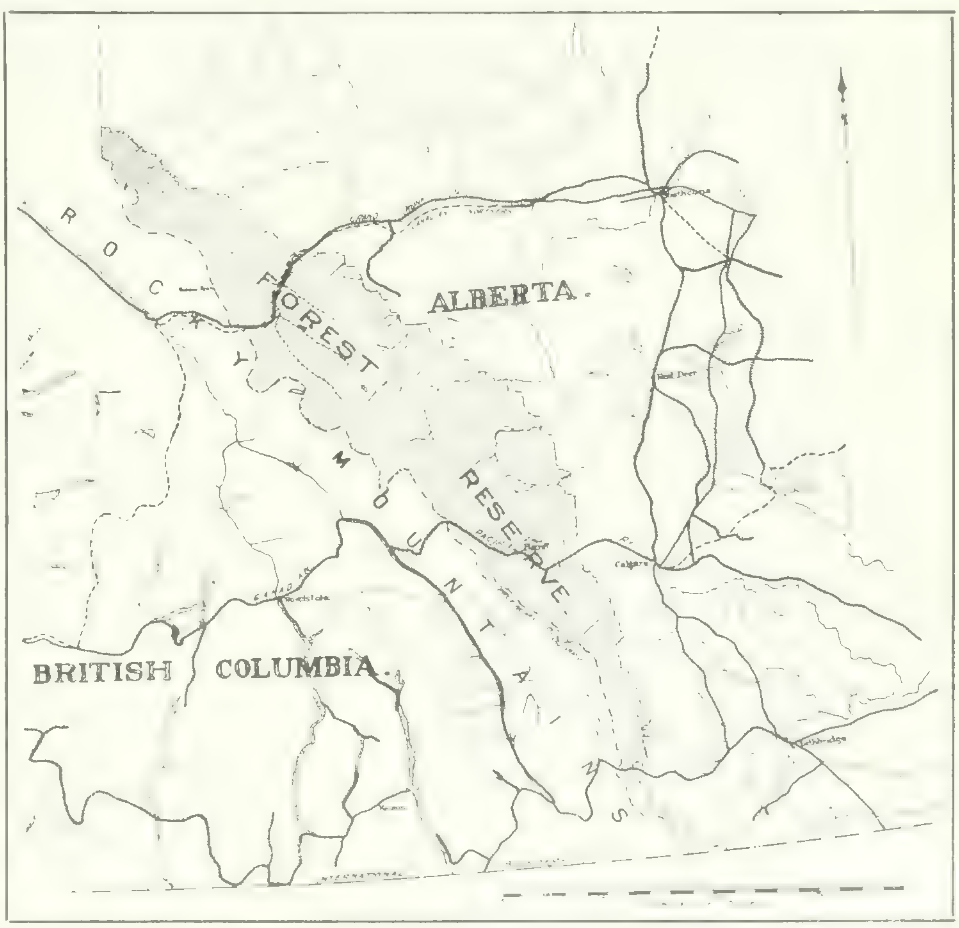

Fig. 1.—Rocky Mountain Forest Reserve.

There has been a steady increase in the use of hardwood ties to replace the softer kinds previously used. At one time there were more cedar ties used than any other kind, but in later years the number used has fluctuated considerably, while there has been a steady increase in the number of hardwood ties used, such as the oak and hard pine. In 1911 the percentages of these two kinds were 1.0 and .003 respectively of the total

number used of all kinds, while in 1912 these percentages increased to 4.4 and 3.1 respectively. There are about 19 different kinds of wood used for ties in this country and Table I. gives the approximate percentage of each kind used.

Table I.

Kind.	Properties.	Percentage.
Jack pine	Light, soft and durable	36.5
Cedar	Light, soft and durable	15.0
Douglas fir	Hard, strong and durable	10.2
Hemlock	Light, soft not strong or durable, brittle	9.1
Tamarack	Heavy, strong, hard and durable	8.5
Western larch	Heavy, strong, hard and durable	5.6
Oak	Tough, hard, strong	4.4
Eastern spruce	Light and soft	3.9
Hard Pine	Hard, tough, elastic and durable	3.1
Chestnut	Light, soft, not strong	1.2
Beech	Very hard, strong, tough, not durable	0.5
Western cedar	Light, soft and durable	0.4
Maple	Tough, heavy, hard and not durable	0.2
White pine	Soft, uniform and durable	0.2
Birch	Heavy, strong, hard	0.2
Red Pine	Heavy, strong, not durable	0.1
Balsam fir	Soft, light, not durable	0.1
Western spruce	Soft, light, not strong	0.1
Elm	Heavy, hard, very strong	0.1

Although the jack pine, cedar, and hemlock have prominent positions in this table their use is practically limited to tracks where the traffic is light, the railways in Eastern Canada having practically discarded these softer woods in favor of oak and hard pine, which are better able to withstand the heavy traffic common to these lines.

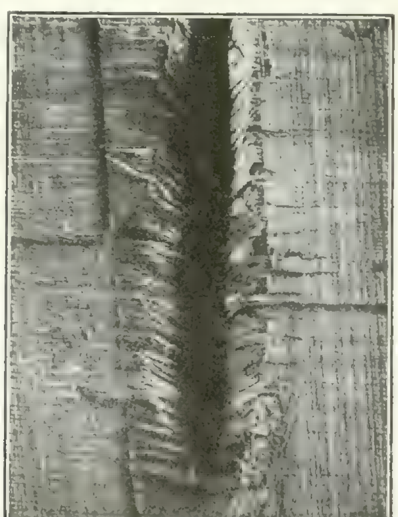

Fig. 2.—Effect of Driving Spike in Oak Tie.

The fourth item on the list of causes of the increased cost of ties to railways is the shorter life of ties. This at first may not be apparent, but it is nevertheless true; the actual time it takes for a tie to decay is no less to-day than it was in the past unless the decay is hastened by some extraneous cause—and that is what actually happens. As the traffic and tonnage over a track increases, so does the rail cutting and mechanical wear of the ties, and once the wood fibres are damaged in this way vegetable decay sets in much quicker, and the life of the tie is shortened by this decay, as well as by the mechanical disintegration.

As is naturally to be expected, both the railways and the governments are doing a great deal to counteract this tendency of increased expenditure on ties and timber, and briefly summarized, the following are the methods adopted for this end: Government legislation and conservation of forest lands; the maintenance of suitable tree plantations by railways; the reduction of mechanical wear by screw spikes, tie plates, etc.; the chemical treatment of ties to prolong their life; and the

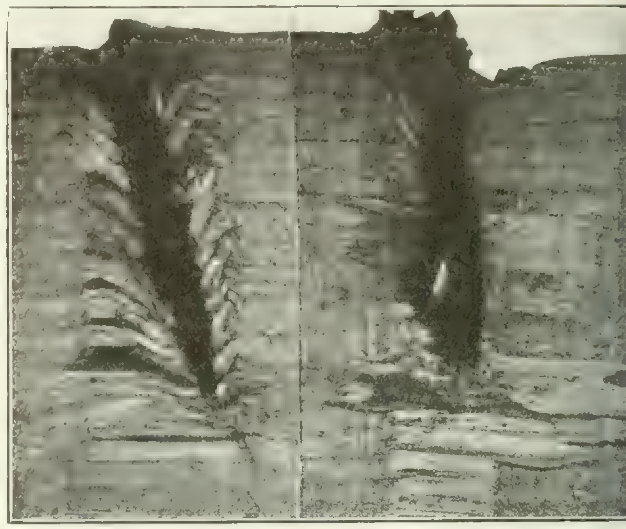

Fig. 3.—Effect of Spike on Tie After One and Three Years' Service.

use of ties of other materials than wood. It might be said that practically all these methods are still in the experimental stage, but it is of interest to note what has been done on these lines.

The Commission of Conservation of Canada has done considerable work in the past few years towards the conservation of the timber supply of the Dominion. In the year 1911 the attention of the Commission was largely paid to the prevention of forest fires, and from careful investigation it was found that about 34% of the forest fires to which causes could be assigned had been started by railway locomotives. As a direct result of this, an amendment was made to the Railway Act requiring railway companies to establish and maintain a service of fire rangers whenever so ordered by the Board of Railway Commissioners, and also requiring the railways to pay damages within certain limits for any fires caused by them. In addition to this legislation, a great deal was done in connection with forest reserves, and as a result the Rocky Mountain Forest Reserve Act was passed setting aside 17,900 sq. mi. in Alberta on the eastern slopes of the Rocky Mountains for a perpetual forest and game reserve. This national forest being the largest and most important in the Dominion, is worthy of a few words of description. As shown in Fig. 1, the eastern boundary is approximately defined by a line at elevation 4,000 ft., the western boundary is determined by the Interprovincial boundary, and the reserve rises to the west to peaks as high as 10,000 ft. The timber line is at an elevation of about 7,000 ft. The most useful trees found in this tract are the Engelmann spruce, the Douglas fir, and the Lodgepole pine. The Engelmann spruce is a tree with a light, soft wood, not very strong and found only in high altitudes. The Douglas fir is of the same species as some of the largest trees in the world, but does not reach such a size in the national

park as elsewhere. They average about 150 ft. high and 3 to 5 ft. in diam. The wood is usually very hard and strong and is useful for ties as well as for heavy construction work, piles, etc. The Lodgepole pine is a very rapid growing tree, has a strong wood and is used a great deal for all kinds of construction purposes.

A number of the larger railways of the United States have been carrying out experiments with plantations of their own on their outlying and other lands. In Table II. is given some of the work done and the cost of planting the trees.

Table II.

Railway and Location.	Kind of Trees.	First cost per 1,000.	Cost of planting per 1,000.
A. T. and S. F. at San Deguito, Cal.	Eucalyptus	—	—
C. B and Q., Ottumwa, Iowa	Catalpa	$10.00	$20.00
Pennsylvania, various	Locust and Red Oak	5.00	5.00
L. and N., various	Catalpa, Walnut, Locust, Poplar	5.00	23.00
D. L. and W. In N. J. and N. Y.	Yellow Locust	23.00	12.00
G. H. and S. A., Texas	Catalpa	16.70	12.00
Southern, Wolf Trap, Va.	"	19.40	7.80
Mich. Cent., various	"	—	—
N. and W., Ivor, Va.	"		—
S. A. and A. P. Ry., Skidmore, Tex.	"	12.65	10.46
St. L. and S. F., Farlington, Kan.	"	11.60	27.10

It will be noticed that the catalpa, locust and eucalyptus (or red gum) trees are the ones most favored for the railway plantations. These are trees which were until recently little known or used, but owing to many kinds of trees which were formerly quite plentiful, becoming more or less scarce, attention had to be given to those trees which would give the best results under artificial conditions. These trees all have the same property of very rapid growth. On the Atchison, Topeka and Santa Fe Railway ranch at San Deguito, Cal., 500 trees are planted every year of the blue gum and eucalyptus species. This tree is a native of Australia, but is successfully reared in California. It grows in low, swampy ground and also equally well in dry, arid mountain plains. It needs a warm climate as the young trees cannot withstand more than 2 or 3 degrees of frost. Freshly cut, the wood is pale in color, heavy, hard, durable, and very difficult to split. It is expected that by the time the trees are 20 yrs. old, they will yield 8 ties per tree, in addition to a quantity of by-products The catalpa tree is a native of the Mississippi Valley, but has been naturalized in many other localities east of the Rockies. The wood is coarse, brittle and not very strong, but is very durable in contact with soil. The trees grow from 40 to 60 ft. in height and 3 to 6 ft. in diam., with well formed trunks and large white, faintly mottled flowers. The yellow locust trees are widely cultivated in the States east of the Rockies. The wood is tough, durable, and unequalled for torsional strength. It has been classed in the first rank of American woods. The trees develop very rapidly but are subject to the depredations of insect borers. They grow from 50 to 70 ft. in height and 2 to 3 ft. in diam.

Protection of Ties From Mechanical Wear.—Many experiments have been made and remedies suggested for eliminating the damage done to a tie by such external agencies as the spike, rail-cutting, etc. When an ordinary cut spike is driven into a tie the wood fibres are broken, torn and generally disrupted. At the time the spike is first driven the damage is comparatively small, but as time passes decay sets in with greater rapidity and the tie becomes rotten around the spike. In Fig. 2 is illustrated the effect on an oak tie of driving into it an ordinary cut spike. In Fig. 3 is shown the resulting effects after one and 3 years' service. One method of obviating this damage to the wood structure of the tie is to bore a hole in the tie slightly smaller than the spike itself, so that when the spike is driven in the usual way there will be practically no damage to the wood fibres. The resisting power of a spike driven into a bored tie is very close to that of a spike driven in the ordinary way. (See Table III.). The comparatively small amount of damage that is done to the tie by a spike driven into a bored tie is shown in Fig. 4. Another method which has been largely experimented with is the substitution of a screw spike for the ordinary cut spike. The screw spike is being adopted as a standard by some of the railways in the States to be used in conjunction with tie plates. The screw spike can be used either as a direct fastening to the tie, or, as is almost invariably done in Europe, it can be screwed into a wooden plug or "dowel" first screwed into the tie. The question of the advantage or disadvantage of the dowel is one on which there is considerable difference of opinion, but the tests show that the screw has a greater holding power when used in conjunction with the dowel than when driven directly into the tie. Since the advent of chemically treated soft wood ties, the hardwood dowel has a distinct advantage of distributing the strain over a large area of the soft wood and also permitting the preservative chemical to reach the innermost pores of the wood at the point where it is most required. A standard screw spike used with and without a dowel is illustrated in Fig. 5. Table III. gives the holding power, as obtained by tests, of different kinds of spikes.

Table III.

	Mean. Lbs.	Maximum. Lbs.
Square spike in unbored tie	4,558	6,826
Round spike in unbored tie	2,478	6,066
Square spike in bored tie	4,082	5,810
Round spike in bored tie	4,108	6,940
Screw spike in bored tie	6,916	10,842
Screw spike in oak dowel	8,170	9,724

Tie Plates.—The use of tie plates is becoming more general on all the larger railways every year. A great many experiments have been made in order to determine the best type for use under varying conditions, but unlike track rails, the tie plate has not yet reached the stage of being standardized by any of the large engineering or railway institutions, and one well-known manufacturer of tie plates, who started with about 2 or 3 different styles, is now manufacturing 40 or 50 different kinds, some of them so similar that when placed side by side it is difficult to pick out the original plates from the more recent innovations. There is a great deal of difference of opinion on all the different points necessary to make an ideal tie plate. For instance, taking the under side, there are the questions of the proper number of flanges, their depth, position, and whether they should be longitudinal or transverse, or whether some form of claw is not preferable to a flange; or again, some advocate a tie plate with a perfectly smooth bottom. Taking the upper surface without considering the problem of the shoulders there are the questions, should it be smooth or corrugated, channelled or bossed? Even with regard to the spike holes there are points of difference in the standards of almost every railway.

The purpose of a tie plate is to distribute the load from the rail over a larger area of the tie than that covered by the base of the rail in order to reduce the abrasion of the tie by the cutting of the rail; to prevent decay of the tie from the same cause; and also to assist

in keeping the track to gauge and line on curves and places where there is a tendency of the rails to spread. By fulfilling these requirements the tie plate has the great advantage that it enables a comparatively soft tie to be used to advantage in places where the traffic is heavy, and in addition to this it will also prolong the life of a hardwood tie. A sub-committee of the American Railway Engineering Association devoted a great deal of time to the special study of this subject and took measurements of the actual abrasion of ties in service with and without tie plates. The opinion formed by this sub-committee was that flanged tie plates of suitable design, width and thickness, and properly applied on tangents as well as on curved track will lengthen the life of cross-ties to 2 or even 3 years, and in the meantime the track will have been maintained in better surface and line and at less cost than could have been done without the plates. The averages of the results obtained of measurements of the abrasion of ties by rail-cutting are given in Table IV.

Fig. 4.—Cut Spike in Bored Tie. **Fig. 5.—Screw Spike in Bored tie (left) and With Dowel (right).**

Table IV.—(White Oak Used for Ties Throughout) Abrasion of Ties by 85-lb. A.S.C.E. Rail, Without Tie Plates.

Alignment.	Traffic.	Age.	Outside edge of base of rail.	Inside edge of base of rail.	Remarks.
Tangent	Heavy	7 to 8 yrs.	[illegible] in.	[illegible] in.	Single track
"	"	8 yrs.	5/8 in.	3/8 in.	East Bd. track
Curve (slag ballast)	Light		[illegible] in.	[illegible] in.	Inner rail, yard track, outer rail tie plated, no abrasion
Tangent	Heavy	5 yrs.	3/4 in.	1/2 in.	East Bd. track
" (gravel ballast)	"	6 yrs.	1 1/16	[illegible] in.	
5 deg. curve	Heavy	—	3/4 in.	3/16 in.	Inner rail outer rail tie plated, no abrasion.
2 " "	Light	—	[illegible] in.	[illegible] in.	Fast Pass. trains
1 " "	"	—	[illegible] in.	[illegible] in.	" "
Tangent	"	—	[illegible] in.	[illegible] in.	" "
8 deg. curve	"	—	[illegible] in.	[illegible] in.	Tie plate on opposite ends of ties, no abrasion.

The requirements of a tie plate in general are as follows: The plate must be rigid enough to equally distribute the rail load over that part of the tie which it covers. If the plate is too thin it will buckle and the load will be transferred to the tie through a thin strip of metal the same width as the base of the rail, and the value of the plate for distributing the load will thus become nil. The tie plate must be rigidly held to the tie so as to prevent dirt and water collecting between it and the tie, and a great many railways favor the plate being so well embedded into the tie by means of flanges or claws so as to assist in the lateral displacement of the rail. In the case of flanges being used they should be deep enough to grip the wood but they should not be so deep as to damage the wood fibres, and when the flanges are placed longitudinally they help very considerably to make the plate rigid and the thickness can consequently be reduced.

In Table V. reports to the American Railway Engineering Association have been compiled to give a general idea of the different standards adopted in 1913 by the larger railways of the continent. A great deal of the variation is in the minor details and it must be borne in mind that what is suitable for one purpose would be absolutely unsuitable under different conditions. It is probable, however, that more universal standards will be adopted in the near future.

Table V.

Railway	Type of plate	No. of holes	Outside dimens. of plate
			Ins.
A. T. & S. F.	Pronged or corrug'd, transverse flange*	4	9x7½
Al. Cent. & Hud. Bay	Sellers patent	4	8½x6–80-lb.
B. & O.	Various	3	9x7–100-lb.
Bangor & Aroostook	Claws	2	8½x5½–80-lb.
Boston & Maine	Longitudinal flange	5	8¾x5–85-lb. 9x5–100-lb.
B. R. & P.	Claws	4	9x7.
C. C. C. & St. L.	Longitudinal flange	4	8½x6–90-lb.
Chicago & Gt. West'n.	Longitudinal flange	4	8¾x6⅛.
Chicago & Alton	Corrugated and Sellers	3	6½x6–80-lb.
C. & N. W.	Corrugated Sellers pat. bottom	2	9x6–100-lb.
C. B. & Q.	Sellers pat., also transverse flange	2	9x6–100-lb.
Can. Pac. Ry.	Sellers pat., also corrugated	4	8½x6½–80-lb.
Denver & Rio Grande	All types	4	8½x5–80-lb.
Frisco Lines	Longitudinal flange*	4	8¾x6½–80-lb.
Gt. Northern	Transverse flange	4	8½x6½–90-lb.
Grand Trunk	Longitudinal flange	4	9x6–100-lb. 8¾x5–80-lb.
Ill. Cent.	Flat bottomed	4	8¾x5⅞.
Lehigh Valley	Transverse flange	3	9x7–100-lb.
L. & N.	Claw	2	8x6–90-lb. 7½x6–80-lb.
Long Island	Longitudinal flange	4	9x6–100-lb. 8x6–80-lb.
Miss. Pac.	Flat, and corrugated	4	
Mich. Central	Transverse flange*	3	9x6–100-lb. 9x5–100-lb.
Northern Pac.	Longitudinal, for tans. and curves less than 3 deg.	3	8½x6–90-lb.
Northern Pac.	Pronged for curves over 3 deg.	2	8½x6–90-lb.
Norfolk & West'n	Longitudinal flange	4	9½x6–100-lb.
New York Cent.	One Longitudinal flange	4	9x6–100-lb. 8½x6–80-lb.
National of Mex.	Flat bottomed	4	
Pennsylvania, East	Transverse flange	6	13½x7–100-lb.
Pennsylvania, West	Pronged	4	9x7–100-lb.
Philadelphia & Read'g	Flat bottom	4	10x7.
Pittsburgh & Lake E.	Flat bottom*	4	8½x7.
Rock Island Lines	Flat with screw spikes, trans. flange, with cut spikes*	4	9½x6½–100-lb
T. & North Ont.	Sellers patent	4	8½x6

*Cut spike and screw. In all other cases cut spikes only.

From this table it will be seen that the great majority of railways are using a tie plate with some form of a flange, corrugation or claw which penetrate the wood of the tie, in preference to the smooth bottom plate. It has been claimed that a plate with a flange tends to break and check the tie, but the common experience seems to be rather to the contrary provided the plate is properly seated to the tie. There have been a great many cases put on record where ties with flanged plates have been removed from the track in a state of decay, but the has a shoulder in order to relieve the spikes of the lateral pressure of the rail. At the other end of the plate the top slopes down slightly in order to drain any water off its surface; to give the plate a grip on the ties it has corrugations running diagonally across its bottom surface. They are of moderate depth, as shown in Fig. 7, with the idea of enabling them to compress and grip the wood fibres without splitting open the tie, and admitting water and dirt. The plate takes sufficient hold on the

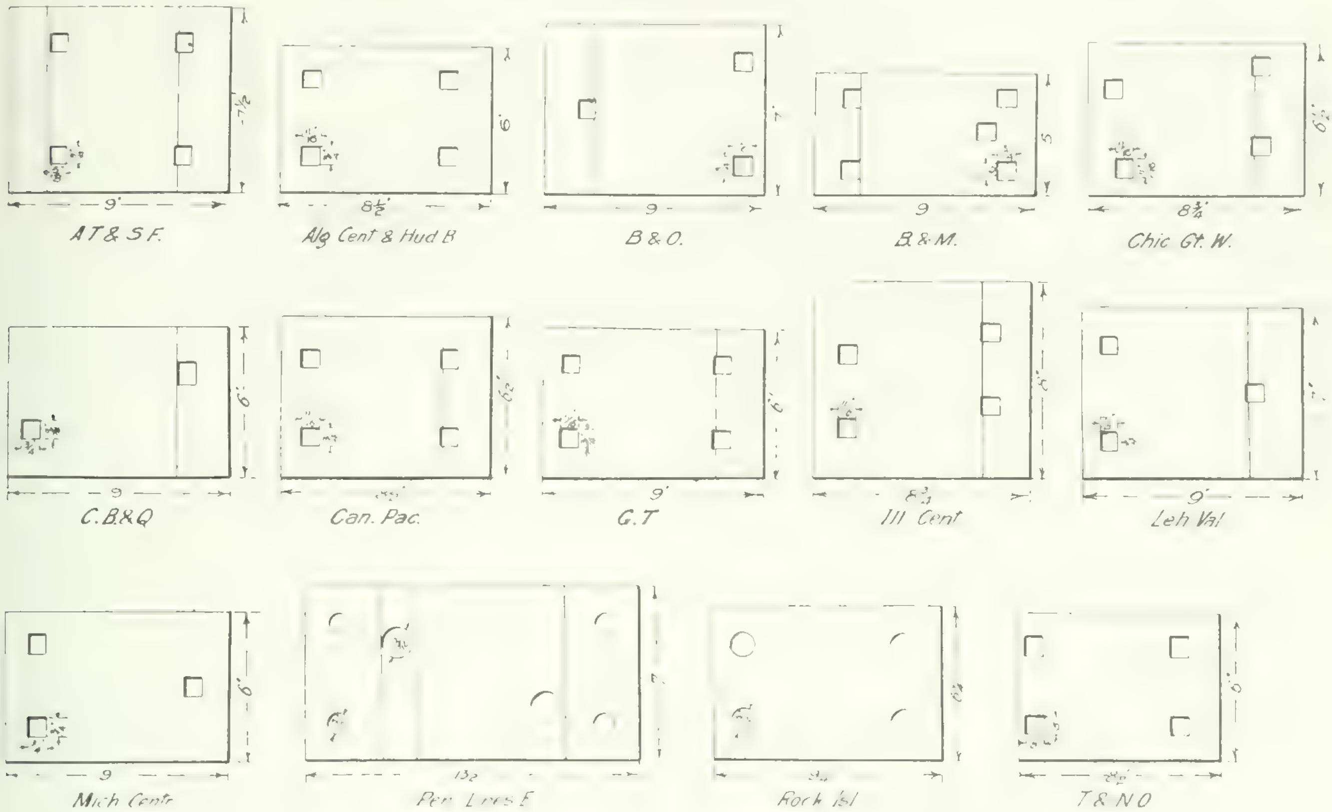

Fig. 6.—Different Forms of Standard Tie Plates.

portion under the plate has been no worse than the rest of the tie, and in many cases it has been found to be in ever better condition. Advocates of the transverse flange claim that the longitudinal flange does not give the necessary resistance to lateral displacement of the plate, whereas the transverse flange will give a big resistance to lateral displacement and at the same time the flanges do not need to be deep enough to damage the tie. On the other hand, it is claimed that the longitudinal flange wood surface to keep the track to gauge without pressure on the spikes.

In considering the relative merits of different tie plates the financial side of the question must not be overlooked. It stands to reason that the cost of the tie plate itself must not be so great as to negative any saving on the cost of the tie. It is difficult to put an actual value in dollars and cents on the services of the tie plate in keeping the track to line and gauge, but at the same

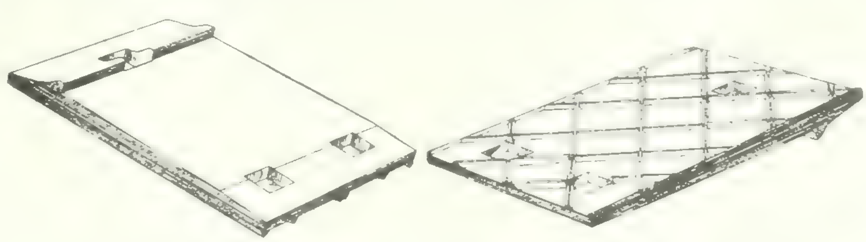

Fig. 7.—Top and Bottom Views of Sellers' Patent Tie Plate.

causes less damage to the ties, adds greatly to the buckling strength of the plate, and at the same time keeps the plate seated to the tie well enough to provide the necessary lateral resistance. It will be noticed that the Sellers patent tie plate is mentioned frequently in Table V. This plate is rolled from wrought iron, the top time the plate should increase the life of the tie to such an extent as to pay for its own cost, provided it is properly designed and applied.

[The question of the preservation of ties by chemical treatment and the use of ties of other materials than wood will be dealt with in subsequent articles.—Editor.]

CANADIAN SOCIETY OF CIVIL ENGINEERS

DETAILED REPORT OF THE PROCEEDINGS AT TWENTY-EIGHTH ANNUAL MEETING, HELD IN MONTREAL, JANUARY 27, 28 AND 29TH — RETIRING ADDRESS OF MR. PHELPS JOHNSON — REPORTS FROM THE VARIOUS BRANCHES, ETC.

The twenty-eighth annual meeting of the Canadian Society of Civil Engineers opened on Tuesday morning, January 27th, with an attendance that almost filled the auditorium of the Society's headquarters at 176 Mansfield Street, Montreal. Registration continued throughout the first two days and an exhausted supply of membership badges indicated that the attendance well exceeded that which had been anticipated.

The President, Mr. Phelps Johnson, was in the chair at Tuesday morning's session.

The meeting was called to order at 10.30 a.m. and the minutes of the last annual meeting were read and adopted. The President announced next order of business to be the appointment of scrutineers for votes for Officers and Members of Council. The following names had been suggested, viz., Messrs. J. Ewing, G. E. Fiset, R. McKillop, S. Blumenthal, V. A. G. Dey, B. Stewart, H. P. Borden, and B. O. Eriksen, and the pleasure of the meeting that they be delegated for the work was ascertained. In addition it was stated that scrutineers would be required for the amendments of by-laws. It had been suggested that Mr. E. C. Kerrigan take charge. He would need three or four assistants. The names of Mr. J. S. Hall and Mr. Robertson had been suggested. The President secured the concurrence of the meeting in the selection, together with power to add one or two to their numbers.

The President then reminded the members that they had been handed the report of the Council, and asked that it be received so that it might be open for discussion. It was moved by Mr. G. A. Mountain that the report be received. Mr. Leofred observed that there was a slightly larger attendance at the last annual meeting than this year, and wondered if a number of the western members were absent because they were dissatisfied with the place of this meeting. At the last meeting, he stated, a very large majority of them wanted the meeting to be held in the West, and it appeared to him that the ignoring of their wishes had caused the smaller attendance.

Mr. Rust stated that this matter was explained to the Western members, and it had been decided to go to the West next year, and that he had heard no expression of disapproval from any members from the West. They were perfectly satisfied that the Society should meet out there next year, and were not dissatisfied with the arrangements.

The President added that the action of the Council in not going to the West this year had met with the entire approval of the Victoria branch. At the time the post card vote had been proposed and sent out no one considered the fact that there would, perhaps, be two new transcontinental railway lines in operation to the coast next year, and it was not considered that the San Francisco Exposition would be in progress together with an Engineering Congress.

Report of Council.—The meeting then received the report of the Council. It was moved by Mr. Rust and seconded by Mr. Butler that the report be adopted.

Mr. Brayley asked if this report included the financial statement. Prof. McLeod replied that it was only as far as page 17 of the report that was then under consideration. Mr. Rust's motion carried and the report was adopted.

The President then announced that the report of the Library Committee was before the meeting and asked for any comment in connection with the report of the Library Committee or the House Committee.

Moved by Mr. Marceau and seconded by Mr. Brown that the report be adopted.

The President brought up the report of the Financial Committee to be found in the same pamphlet (pages 26 to 30). The statement of revenue and expenditure was on Pages 26 and 27; assets and liabilities on Pages 28 and 29, and on Page 30 was given the cost of the new building up to date.

Moved by Mr. Papineau and seconded by Mr. Lawrence that the report be received. It was then opened for discussion.

Mr. Brayley asked the meaning of the $5,000 on Page 26 of the assets and requested that it be explained.

Prof. McLeod explained that the Society had that much cash in the bank bearing interest. If it were put in the ordinary current account it would not be bearing interest.

Mr. Brayley asked if that account included the commuted fees. Prof. McLeod replied that it did not and that the commuted fees were very small.

Mr. Mitchell observed that in any case they would amount to several hundred dollars and enquired if that meant those who had become life members.

Mr. Brayley asked what was the total of the arrears fees. He noticed on Page 26 they were shown as $5,000. He desired to know what proportion that was of the total.

Prof. McLeod stated that a special statement would require to be made on that. It was carried forward from year to year. The auditor had thought that the Society had better keep that amount as representing the outstanding amount for arrears. He presumed an answer could be had for Mr. Brayley's question and given to him at the afternoon session.

Mr. Mitchell then asked how much of that represented arrears of over two years' standing.

Prof. McLeod agreed to include that in the afternoon return.

Mr. Brayley noticed an item of accounts outstanding, totaling $3,036, and asked if that was more than was general. Were they 30 or 60 day accounts, or did they run over a longer term?

Prof. McLeod replied that it was based largely on outstanding accounts entailed by printing.

Mr. Brayley stated that the Society had arrears fees and current fees, which would be used, presumably, for maintenance. Then it had advance fees and entrance fees which might be used more for buildings. Were any divisions made or was the Society being operated on entrance fees as well as current fees?

The President replied that he thought the total revenue had been just enough for the running of the Society.

Mr. Brayley made a suggestion that the Financial committee try to establish a more scientific basis of distribution for next year.

The President called attention to the fact that the surplus was only $646 and that the Society was running very close in the matter of finances.

It was moved by Mr. Mountain and seconded by Mr. Francis that the report of the Finance Committee be adopted.

Committee Reports.—The President then announced the next business as the reception and adoption of reports of Committees on Track, International Electrotechnical Commission, Reinforced Concrete, Sewage Disposal, Conservation and Testing Laboratories.

Prof. McLeod observed that it was customary for the chairmen of committees to present these reports, but that he had a telegram from Mr. Safford, Chairman of the Committee on Track, that he could not be present.

Mr. Francis, Chairman of the Committee on Concrete and Reinforced Concrete then presented the report of that committee re standard specifications for concrete and reinforced concrete, with the following letter of transmittal:

Mr. Francis.—In accordance with the instructions of the Council I beg to hand you herewith, for discussion by the membership of the Society, a preliminary draft of Standard Specifications for Concrete and Reinforced Concrete.

Owing to the immense amount of work involved in the preparation of a Standard Specification for Concrete and Reinforced Concrete, the Committee has been unable, in the time at their disposal since their appointment, to complete a document with which they feel entirely satisfied. In view of the fact, however, that the last Annual Meeting expressed a desire to have a standard specification, and that it is highly desirable that such a document should be available to the membership, the Committee recommends the adoption of the draft now submitted, after it will have been discussed by the membership.

At the same time the Committee respectfully requests that it be continued for another year in order that the work may be perfected, and that further knowledge may be obtained regarding shear action in beams. Should the request be granted, Mr. Morssen has kindly consented to make a number of test specimens upon which Professor Brown and Professor MacKay have been good enough to undertake to experiment, in order that this subject may be more fully understood.

In submitting this draft I should like to call attention to the personnel of the Committee, which is composed of engineers in various branches of construction. It contains representatives of McGill University, University of Toronto, Ecole Polytechnique and the University of Manitoba, as well as those engaged entirely in concrete and reinforced concrete construction, in steel construction, in bridge work and in private practice.

In the course of our work, upon which a great deal of time has been spent both in private and in committee meetings by many members, very liberal use has been made of all the latest authoritative documents on the subject, not only in the English tongue but in French and German. In addition the Committee has been most fortunate in having Mr. Morssen search also the Austrian and Swiss literature.

It is with the greatest of pleasure that I acknowledge the hearty co-operation of the members of the Committee, and particularly the indefatigable interest of Mr. Mattice, Mr. Monsarrat, Mr. Morssen, Professor Brown, Professor MacKay, Mr. Rolph, Mr. Gillespie and Dr. Galbraith.

[For a complete copy of this report members are referred to Pages 198-203 of January 22nd, 1914, issue of The Canadian Engineer.)

Mr. Francis then moved that the report be received, and that the Committee be continued until next annual meeting with instructions to make a final report.

Mr. Brown suggested an amendment, if acceptable to Mr. Francis, viz., that the committee confer with similar committees of other engineering societies, especially with the American Society of Civil Engineers and Institution of Civil Engineers, now making investigations along similar lines, with the idea of unifying the work, and making it universally wide in scope, thereby getting the best results

Mr. Francis replied that he would have very great pleasure in including Mr. Brown's suggestion with the motion if it were practicable, but that the committee had already made use of the reports of the other societies which were working for a long time along these lines. The Committee adopted their symbols, and had done everything possible to make the work conform with what other societies had been doing. The work of other Committees had been followed as closely as possible, not only in America, England, Ireland and Scotland, but in France, Germany, Austria, and Switzerland. It would be impracticable, Mr. Francis thought, to have a complete document ready inside of many years. These committees were composed of the most eminent engineers. They had a great deal of money at their disposal and this committee had not. Following the assumption of the last annual meeting it had merely presented the present draft for discussion. If this meeting allowed the work to go on, Mr. Morssen, as stated, had very kindly consented to make a series of special beams for the McGill Laboratories and the Professors of the University had stated their willingness to test them.

A discussion by Mr. Elmont followed:—

Mr. Elmont.—Mr. President, I would like to suggest that the specifications, which now deal comprehensively with both plain Concrete and Reinforced Concrete, should be arranged in such a way in the final draft, that the specifications for Concrete and those for Reinforced Concrete would be completely separated.

If they were bound in one pamphlet and the Reinforced Concrete specifications printed first, it would only be necessary to print in full a few sections for plain Concrete; while further information could be given by references to corresponding sections in the reinforced concrete specifications. As plain concrete and reinforced concrete structures are so widely different, I think that the specification would gain in clearness and practicability by this separation. A contractor who had to build a mass concrete structure according to this Society's specification for concrete structures, would, under the arrangement mentioned, find all the requirements his work had to meet under its own heading and concisely defined.

If it should be decided that it was desirable to separate the specifications, I would further suggest that the reinforced concrete specification be prefaced by a responsibility clause in accordance with the general practice followed by engineering societies.

As the specifications are arranged at present, Section 1, for instance, applies to all structures in which concrete is used. Undoubtedly, only Portland Cement should be used for reinforced concrete, but where economical conditions and the nature of the structure allow, it appears to me, that natural or slag cement should not be prohibited. This could be mentioned in the concrete specification, while the reinforced concrete specification would only permit Portland cement

In Section 3 it is stated that the fragments of the crushed stone shall pass a circular hole 2½" in diameter. The maximum size for reinforced concrete is given in Sections 56 and 57, while it seems correct, also, to place these figures under Section 3 of "Materials." I would suggest, that instead of giving the maximum size of 2½", which, it might be stated, might quite properly be exceeded in a number of structures, that the maximum size depends upon the nature of the structure. It would, perhaps, be well to mention some of the structures in which the size must not exceed ? or 2½"

As called for in Section 6, it is, no doubt, preferable that only fresh water should be applied to reinforced concrete, until further experiments have been made to determine the influence of the salt water, but for many mass concrete works, salt water is quite permissable.

With regard to the other paragraphs of the specification, I would like to submit that the headings "Method of Calculation" on Page 10, "Unit Stresses" on Page 12, and "General Requirement in Design" on Page 16, should be arranged as subheadings under a general heading called "Design."

The title of Section 19 might with advantage be changed to "Assumptions for Calculation" as they apply to all reinforced concrete design, and not only to beam and slab design. I would also suggest changing the beginning of the Section to read "Unless a more exact calculation is made, the calculation shall be based upon the following assumptions"; and placing Section 30, which is also a mere assumption, for the calculation, as "g"; also leaving out the 2nd, 3rd and 4th lines under "d", as these lines do not contain a new assumption, but simply a logical conclusion from the premises given in this Section.

The 2nd line of Section 20 I would suggest should be changed to, "A slab at the compression side of a beam may be............", and after the last word in the first paragraph, might perhaps be added, "When the main reinforcement of the slab is parallel to the beam, only half of the above given widths should be taken as an integral part of the beam. I would recommend that the three first lines of the 2nd paragraph of Section 20 be left out, as in many designs the slab is placed at the bottom side of the beam over the supports, and so would not agree with the paragraph as it stands. The same would be the case if there was no reinforcing in the compression side over the supports, which is not impossible.

In reference to Section 21, I would submit to the Committee, if, in the interest of the public safety, it would not be advisable to adopt some regulation for flat slabs, perhaps in line with those given in the building code for the City of Cleveland.

Section 23 does not state the size of the test piece from which the ultimate strengths are determined; this will no doubt be added in the final draft.

Section 31 gives the physical properties of the steel reinforcement, but does not mention the chemical requirements. They are, of course, generally agreed upon, but as they can be given in a few lines I would submit that they should be stated.

The first line of Section 33 states that "not more than three parts of sand shall be added to one part of cement"; this applies to plain concrete structures, the mortar in reinforced concrete work is determined by Sections 36 and 37. The requirement that the mortar shall not be less than 1:3 is a rather severe one, mixtures 1:4:8 or even 1:5:10 have been and are being used with satisfactory results in numerous cases, where the stresses in the concrete are insignificant, i.e., the main point is weight. For all structures of any importance advance tests should be made compulsory in order to determine the voids and the proper mixture of the aggregates.

In Section 45 it is stated, that "the foundations shall be at least as large as the dimensions on the approved drawings." I would suggest that these words should be left out. Someone might think that this does not apply to the other parts of the structure.

Section 43 deals with the reinforcement in columns. As all experiments bear out the importance of a proper spacing of the ties and the hooping, I would recommend that it be said that the ties should not be spaced farther apart than the diameter of the column, and in no case should they be spaced more than 12", and that the hooping in columns, where it is allowed for in the calculation, should not be spaced more than 1-8 of the diameter and never more than 2½".

The concrete in slabs shall, according to Section 60, be deposited continuously with the concrete in the beams. As far as I am aware, no experiments or practical results prove the urgent necessity of this method of procedure, while numerous experiments plainly indicate that the slab can be concreted when the stem of the beam has set, without any detriment to the united action of slab and beam or to the transmission of shear forces at the joint. If the Committee decides to change this section it should be pointed out, as a matter of precaution, that the web reinforcement should be anchored carefully both in the slab and at the bottom of the beam, and that the joint must not be too smooth and must be thoroughly cleansed before depositing the concrete for the slab.

Some very good measures to avoid failures in reinforced concrete work are established by the regulations given in Section 63, the greater part of the failures which have occured being undoubtedly due to too early removal of the forms. Only a few other societies' reinforced concrete specifications contain such detailed rules as we will secure. Some specifications make a distinction between slabs and beams over and under 10 or 15-foot span. This, I think, is worthy of imitation, now that we are using slabs without beams, resting only on columns of as much as 20 or even 25-foot span, and simply supported reinforced concrete beams have reached the 100-foot mark.

Mr. [illegible] suggesting that the allowable stress of reinforced concrete be reduced. Using concrete of 1-2-4 mix—with hard limestone, the strength had been given as 2,000 pounds. It had been suggested that 30 per cent. be taken, which would give a stress of 600 pounds to the extreme fibre. This made a concrete structure so heavy that it is almost prohibitive.

Mr. Lawrence stated that this was a big subject and that the committee had been working on it a comparatively short time. He suggested that the matter be taken up in Montreal as well as by each of the branches, and that the discussions be turned over to the committee to sift as they saw fit and to make any changes that they might think wise in the specifications. They could report to the membership at large during the year. He felt that it would be unwise to adopt the specification as it stood.

Mr. Mitchell stated, as a member of the Toronto branch, that members were very anxious to discuss the specification in Toronto, but that copies had arrived in Toronto a very short time ago, so that they had had no opportunity. He thought that if the branches could take up the matter as suggested it would be a very great benefit.

The President inquired if there was any further discussion on the subject, and if Mr. Francis' motion covered the point.

A motion was then made by Mr. Francis, seconded by Mr. Morssen: That the draft report as submitted be received; that the discussion thereon be submitted by the branches to the committee with instructions to report to the council, and that the committee be continued until next annual meeting with instructions to make a final report.

Mr. Lawrence inquired if the report would be sent to all the members or would it be left over until next year.

The President replied that it appeared to him to be a matter for the Council, and as soon as they deemed it wise, it be put into form and sent out as a pro tem specification to report progress.

Mr. Lawrence thought that it could be safely left to the incoming Council and that the report should be placed in the hands of the membership before next year. The motion was then carried.

Owing to the non-arrival of the chairmen of the committees on Sewage Disposal and Conservation, the reception of the reports, in order at this point, was postponed until later on.

Concerning the report of the Committee on Testing Laboratories, the President, as a member of that committee, stated that [illegible] found to do had been to [illegible] the Government [illegible] to represent the desirability of having testing laboratories.

Mr. Rust stated that he had met Mr. Keeter, the chairman, in New York, and he had said he would not be able to attend. Mr. Rust suggested that the committee be continued and that an occasional call be made upon the Government.

The President observed that there was a suggestion that the committee should be discontinued, and that the council take up the matter with the Government, whereupon Mr. Rust intimated that the matter could be left to the discretion of the council. It was then moved by Mr. Rust and seconded by Mr. [illegible] that the committee be discontinued and the matter left in the hands of the Council.

REPORT OF BOARD OF EXAMINERS.

The report for the Board of Examiners was given by Mr. MacKay. He remarked that four examinations had been held annually in former years with only a small number of candidates in attendance. During the past year examinations had been held only in May and November. The table in the report shows the number of candidates in each subject, also the number who passed and the number who failed. Two-thirds of the candidates of the whole passed. There had been only one or two candidates present on the primary subjects, i.e., for the membership of juniors. The standard so far adopted had been, he considered, rather easy and the examiners had given the candidates every opportunity and those who failed were certainly too weak to come under the definition as to those who were to be admitted to the Society to be qualified in design as well as practice engineering work.

A large number of men had been accepted on the presentation of certificates from their institutions. The majority of these certificates had come from Europe, largely from England and Scotland, although some had come from continental Europe. There had been great difficulty in such cases in maintaining the standard, because they had come from every sort of institution from a night school to institutions of very good standing indeed. In every case the committee had tried to give the benefit of the doubt to the candidates coming in. The board felt that these certificates should come before the educational committee since they were now in the position of saying who should be sent to examination and who should examine them. It would be more satisfactory to the board if some other party looked after the candidates, and the board could then entirely restrict its work to that of examining.

COMMITTEE APPOINTED RE GENERAL CLAUSES IN SPECIFICATIONS.

As other reports were not ready it was decided to postpone the reading of reports and hear any other matters which might be introduced. Mr. French, therefore, brought up the matter of having general clauses in regard to specifications.

Mr. French said that it would be well for the Society to appoint a committee to govern these specifications. In specifications there were certain things which were common to all. The members might readily call to mind clauses of a simple nature, and his experience had been that there was a wide variety to be met in such clauses. There was evidently a field of usefulness for a committee to consider the matter. He thought that the study of general clauses would be of great benefit to engineers.

Upon the suggestion of the President, Mr. French moved that the matter of appointing a committee to consider the matter of general clauses in specifications be left with the Council. The motion was seconded by Mr. Thomlinson.

The President remarked that formerly the matter of specifications and contracts had been taken up by each department and questioned whether it was practicable to make any specific rules.

Mr. Butler stated that in the province of Quebec the statutes protected the owner sufficiently, whether the engineer and contractor were covered by specifications or not. The province threw upon the engineer and the contractor or architect, as the case might be, the full responsibility for any defect that might develop within five or ten years the exact time having slipped his memory. He knew of a case which had gone to the Privy Council. It was held that the contractor had the onus upon him of knowing the defects of the foundation which were not exposed. This was the spire of St. James Cathedral. In every state of the United Stattes except Louisiana, and in every province in Canada except Quebec, the obligation was upon the contractor. He thought it would be of assistance if the Society could establish some sort of a standard in regard to specifications.

Mr. Francis expressed his belief that it would be very difficult to make a comprehensive specification to include all the trades with which an engineer had to deal. However he thought it would be an excellent thing for a committee to engage in the work of drafting special clauses.

A motion was put by Mr. French that the Council appoint a committee to consider the drafting of uniform general clauses in specifications and contracts which might be used by the profession in conjunction with specific clauses suited to the particular work on hand. He added that if the Society appointed a committee and made a report of their findings, that report would be of great assistance to the engineer in writing up his specifications. He had experienced trouble in writing up specifications,having left out clauses, or at other times put in a great deal more than was necessary.

Mr. Mitchell was inclined to believe that it was a very large order. He felt in favor of the matter being investigated, but was doubtful whether a committee could bring in an actual draft, particularly in a year's time. He understood the motion to say: "Consider the drafting of such a condition." He thought that if such a committee brought in a report on the advisability of the matter for next annual meeting, it would be all could be expected, and then at that meeting the recommendation of a general character which they had made could be discussed and then, if it was thought wise, the committee could be continued to carry on the details.

Mr. French agreed that this was a larger order, but it seemed to him that if a committee were appointed to consider the advisability of the matter and to report to the society at the next annual meeting little progress would have been made. The only thing to do would be to try; and it would be very much better for the committee to make an honest attempt to draw up such general clauses, unless the difficulties were such that they could not be surmounted. If the work progressed satisfactorily no member would begrudge the necessary time to make the trial complete.

The President asked Mr. French if it was his wish that this committee be appointed at the meeting or that it be left in the hands of the council; whereupon Mr. French expressed no preference in the matter. He merely desired to bring it to the attention of the Society. Mr. French's motion then carried.

Mr. Brown, managing engineer of the Mount Royal Tunnel, brought up the matter of giving the members an opportunity of seeing the tunnel on Thursday afternoon at 3 o'clock. Instructions were given for everyone to

prepare for a walk of two miles under Mount Royal, and not to expect to find the tunnel in any way dry.

Mr. White, Chairman of the Committee on Conservation, had arrived, and, at this stage read his report on Conservation. (See Page 204, The Canadian Engineer, for January 22nd, 1914). It was adopted, with the exception of the last six paragraphs., i.e., down to "Federal Government." Opposition to the passing of the report in toto was raised by Mr. Butler, who objected to the references to denatured alcohol, as not being along the lines of the Society. He objected to its undertaking to prescribe the policy for the Government with respect to alcohol. He expressed similar feelings in connection with the report's reference to sawdust utilisation.

Mr. White, very willingly, agreed that the portion objected to be dropped, whereupon his motion to adopt the report was seconded by Mr. Mitchell, and carried.

A motion was then put by Mr. Mitchell, which read as follows:

"That this Society commends the work of investigation being done by the Hydro-Electric Commission of the Province of Ontario, with respect to the control of the Grand River, and expresses the hope that the Commission will continue similar investigations throughout the province;

"That the Council communicate this resolution to the Commission."

Mr. Dion objected on the ground that the Hydro-Electric was not only a Commission, but was engaged with private interests. He thought it unwise for the Society to take any definite interest..

Mr. Mitchell contended that the purport of his motion was entirely in accord with the policy of the Society, and felt that it should commend such scientific investigation of great value to the public.

Mr. Coutlee remarked that it was rather difficult to make a recommendation other than a very general one, adding in a jocular manner that such commendation could not very well exclude the Ottawa River work, which brought loud applause from all members familiar with his connection with the same. Mr. Coutlee occasioned further smiles by his remarks concerning the Grand River and his suggestion that the vote of commendation be sent to those who live along its banks.

Col. Anderson did not think there was anything wrong in the procedure. It was not a question of the work. It seemed this Commission had done some scientific work as well as commercial work and that the motion was commending the scientific part of it.

The President called for a rising vote upon the motion, but it was lost.

The meeting then adjourned until the afternoon, the visiting members going to the Windsor Hotel, where they had a delightful luncheon as the guests of the Montreal members.

The meeting adjourned until 3.30 p.m.

TUESDAY AFTERNOON SESSION

The President announced that there were two additional reports on hand, one from the Cement Committee and one from the Sewage Disposal Committee. No member of the Cement Committee was present at the time to read the report, whereupon the President submitted two recommendations, one that the Council should select two general subjects out of the ten for first consideration and report. The second was in view of the volume of work done, and indicated that the membership should be increased from three to ten. The President then inquired if it was the pleasure of the meeting that the committee be continued, and that its recommendations be left in the hands of the incoming Council. Affirmed unanimously.

The President then called attention to the report of the Sewage Disposal Committee, observing that Mr. Chipman, a member of that committee, was present and intimating that the meeting would be pleased to hear from him. The report being brief, the secretary was asked to read it. Mr. Chipman then formally presented it to the Society.

The President inquired if it was the desire of the committee that the matter be left in abeyance, but Mr. Chipman, as a third member of the committe, felt hardly in a position to say. Mr. Johnson remarked, however, that it was rather important that the meeting take some action. Col. Anderson then moved that the report be adopted, and that the committee be retained.

Mr. Leofred rose to remark that this work was becoming more and more important, and thought the House of Commons was hardly prepared to meet the growing agitation. It would need a great deal of further study to see to what extent the towns were in a position to make a decision. He referred to the city of Verdun as bearing out his remarks. There was a liability of towns by reason of their inability to cope with the situation, and their inability to arrive at any decision on the matter, suffering severely through lack of proper knowledge and enormous expenditures. There was no question but that the matter required a great deal more study and investigation, and there was, in his opinion, no lack of work for this committee.

It was moved by Col. Anderson, and seconded by Mr. Mountain, that the committee be continued, with power to increase their membership. Carried.

It was then moved by Mr. C. H. Mitchell at the request of the president, and seconded by Mr. Francis, that the report of the committee for Cement be left until the next meeting.

COMMITTEE ON IMPROVED ENGINEERING SERVICE.

Col. Anderson, as a member of that Committee, and in the absence of its Chairman, stated that the idea of the Committee was to approach the Government with the intention of having the Engineering Service put on a more permanent basis, and that it be established with promotion and super-annuation. Most of the engineers in the employ of the Dominion Government were temporary employees. Reports had been made to the late Government with regard to this matter, and the Committee had been promised that the question should be taken up by the legislation. But since that time the Government had changed and it was necessary to begin the work over again. The present Government, especially the Minister of Public Works, had received the Committee very cordially, and had promised that the matter should be taken up in Parliament, but up to the present no action had been taken. It was very desirable, however, that the Engineering Service of the Government be put on a much better footing. (Applause.)

Mr. Leofred remarked that if anything was to be done it would be well for a delegation to go to Ottawa to try and accomplish the aim in Colonel Anderson's remarks. The motion that the Committee be continued was carried unanimously.

The P[illegible] report as that of the Educational Requirements Committee, and asked Mr. Marceau, the Chairman of that Committee, to submit his report.

Mr. Marceau stated that there was very little to report, and it was moved and seconded that the Committee be continued.

Mr. Johnson then took up the report on Steel Bridge Specifications and upon motion by Mr. Duggan, seconded by Mr. Butler, it was decided that this committee be also continued.

Upon taking up the remaining reports, that from the Committee on Rails, Mr. Mountain, as a member of the Committee, stated that it had done a lot of good work, but was not yet prepared to make a final report. They desired that it be continued, and wished to add the names of Mr. Butler and Mr. Stewart. These gentlemen, having consented to act, the motion was seconded by Mr. Rust and unanimously carried.

Mr. McLeod announced that at the request of Mr. White, the Chairman of the Committee of Conservation, the members of that committee meet Mr. White at the adjournment of the afternoon session.

While on the matter of committees, Mr. Mitchell proposed the formation of a Committee on Cast Iron Water Pipes and Specials. A report had been submitted by a committee some four years ago, but since that time it had not been worked upon either by the American Society of Civil Engineers or by our own Society. There had been found, however, matters in which improvement could still be made by other societies ,and they were making further studies. Mr. Mitchell, therefore, thought it was incumbent on the Society to do so as well. He proposed that a committee beformed to report at the annual meeting next year, and suggested the names of the following gentlemen:

Messrs. T. C. Irving, Jr., Chairman: Newton J. Ker, A. Currie, F. H. Pitcher, C. H. Mitchell, F. X. Leofred, C. L. Fellowes, and others.

Mr. Pitcher seconded this motion.

Mr. Irving moved that the committee appoint its own chairman, and Mr. Leofred, in seconding Mr. Irving, said he thoroughly agreed that the committee appoint its own chairman.

Mr. Mitchell, on a reminder from the Chairman that the minutes contained a ruling to this effect, said he would be quite willing to alter his motion to read in accordance with the bylaws.

Mr. Johnson then stated that the resolution as moved was that a committee be formed for Cast Iron Water Pipes and Specials composed of the afore-mentioned gentleman, and it was carried unanimously.

Col. Anderson then stated that if there was nothing before the meeting he would like to bring forward the resolution, following up what he had said with regard to the work done by Government engineers. He remarked that he had sent this notice of motion in to the Society over a month ago, expecting it would be sent out in printed form to the members. Continuing, Colonel Anderson said that he did not know if it was necessary to say much about the matter, as every engineer knew these facts, and the attention of the Government should be called to remedy the defects. The Dominion had good facilities at its disposal for obtaining the best results, but the fault appeared to be with the Government itself; there was absolutely no way in which a Government engineer could find out what plans were avail-

able in other Government departments, and this, in itself, was a very great defect. As Colonel Anderson had before stated the Committee had reported to the late Government, and it was now time for the present Government to have it turned up and more action taken with regard to it.

Mr. Butler remarked that the whole of the questions involved in the survey was in the hands of the Department of Militia and Defence and that they might be prevailed upon to take up the matter, and if possible put into effect the recommendations made by the Commission.

Mr. White, in replying to Colonel Anderson's references to the Government methods in matters pertaining to engineering generally, said it was simply a question of convenience. He was of the opinion that if the Canadian Government could be induced to establish an Engineering Corps, there would be no question then as to the establishment of the engineers in the employ of the Canadian Government.

The Chairman then announced the next order of business to be the reading of the reports of the branches.

REPORTS OF THE SOCIETY'S BRANCHES

CALGARY BRANCH FORMED

The first step toward the formation of the Calgary branch was taken in 1912, when Mr. J. T. Child invited a few of the members of the Society, living in Calgary, to meet in his office in the City Hall on July 2nd, to discuss the advisability of forming a branch in Calgary. While those who attended this meeting (six in number) were heartily in favor of forming a branch in Calgary, no definite steps were taken until March, 1913, when a circular letter, bearing the names of J. T. Child, H. B. Muckleston and F. H. Peters, was sent to all the members of the Canadian Society of Civil Engineers residing in the vicinity of Calgary, asking them to attend a meeting in the Government Irrigation Office in the old Post Office Building, on March 12th, 1913. This meeting was attended by nineteen corporate members and one student, all of whom were in favor of starting and signified their willingness to support a branch in Calgary. By-laws were adopted, temporary officers elected and subscriptions started at this meeting. Shortly after a formal application was forwarded to the Parent Society and the Calgary branch became a fact. Another meeting was held in the Government Irrigation Office on June 21st, 1913, and at this meeting the following officers were elected to act until the Annual Meeting in December:—Chairman, H. B. Muckleston; Secretary-Treasurer, P. M. Sauder; Executive Committee, H. B. Muckleston, F. H. Peters, A. S. Dawson, E. L. Miles and P. M. Sauder

Owing to the fact that a very large percentage of our members are engaged in work which takes them out of the City during the summer and fall, no regular programme was attempted during the summer, but a club room has recently been rented and it is expected that a regular programme of meetings, at about two weeks intervals, will be carried out during the winter and spring.

Messrs. T. E. Robinson and P. J. Jennings represented this branch at the Annual Convention of the Western Canada Irrigation Association, in Lethbridge, on August 4th, 5th and 6th, last, while Messrs. H. B. Muckleston, F. H. Peters and P. M. Sauder, of this branch, represented the Parent Society at this Convention.

H. A. Moore, General Manager of the Calgary Power Company, extended an invitation to the members of the branch to visit the new dam and power plant under construction at Kananaskis Falls, which a party of thirty-two accepted on November 29th. This trip was both pleasant and interesting.

The annual meeting was held on December 6th. The Secretary-Treasurer's report at that time showed the total receipts to date (subscriptions only) as $300.00, total disbursements $31.00 and balance in the bank $269.00. The chairman and secretary-treasurer were re-elected to serve another year and together with F. H. Peters, A. S. Dawson and G. Romanes, form the Executive Committee for 1914.

The year was closed by a dinner at 6 p.m., on Decmeber 30th, at which J. S. Dennis, Assistant to the President of the Canadian Pacific Railway Company and a member of the Council of the Canadian Society of Civil Engineers, was the guest of honour and gave a very interesting address on "Early Surveys and Surveyors of Western Canada." Respectfully submitted,

P. M. SAUDER, Secretary-Treasurer.

Calgary, January 10th, 1914.

FEW PAPERS AT KINGSTON

The following is all the report I have to make for Kingston:

The Annual Meeting of the Kingston branch was held on Jan. 23rd, and the following officers were elected for the current year: Chairman, Alexander Macphail; Sec.-Treasurer, L. W. Gill; Executive Committee, L. Malcolm, J. B. Cochrane and G. C. Wright.

On account of the small membership of this branch, there is not much incentive to the writing of papers for branch discussion. [illegible] only a limited number of meetings were held during the past year. Most of these meetings were called primarily for the discussion of proposed amendments to the by-laws of the Society.

Respectfully submitted,

L. W GILL, Sec.-Treasurer.

Kingston, Ont., Jan. 26th, 1914.

OTTAWA'S SPLENDID REPORT

On behalf of the Managing Committee of the Ottawa Branch we take pleasure in submitting the following report for the year 1913 namely:

Annual Meeting.—This was held as usual at the beginning of last October, and resulted in the election of the following officers for the season of 1913-14, namely: Chairman, G. A. Mountain; Managing Committee, M. F. Cochrane, F. J. Delaute, W. J. Dick Alex. Gray and W. S. Lawson; Secretary-Treasurer, A. B Lambe.

The standing Committees were afterwards struck as follows namely: Entertainment, W. J. Dick (Chairman), G. G. Gale and John Murphy.

Papers, Alex. Gray (Chairman), F. C. Askwith, W. S. Lawson and R. F. Uniacke.

Library, F. J. Delaute (Chairman), Valmore Denis, N. J. Slater, and J. C. Stewart.

Rooms, M. F. Cochrane (Chairman), W. F. McK. Bryce, K. M Cameron, and G. B. Dodhe.

The district Councillors are C. R. Coutlee, Ottawa, for 1911-12-13; D. McPherson, Ottawa, for 1912-13-14; S. J. Chapleau, Ottawa, for 1913-14-15.

The District Representative on the Nominating Committee is James White, Ottawa.

Membership.—Quite a number of changes have taken place during the year, as our members are constantly coming and going, but, except in the Student and Ottawa Associate classes, the net results are slight gains, as will be seen from the following table.

	January 1913	January 1914
Hon. Members	3	3
Members	49	51
Associate Members	112	116
Ottawa Associates	25	24
Juniors	12	15
Students	82	28
Totals	283	237

We much regret having to record the death during the year of three members, namely, Messrs. E. Jodoin, H. F. Cole and R. W Farley, and the permanent diasblement of an Ottawa Associate Mr. James Fyfe.

Papers and Meetings.—Our Papers Committee has been very fortunate in being able to present before the branch a number of most valuable addresses, many of which have been of interest to not only our own members but also to quite a large section of the general public. This has produced in several instances attendances far too large for our own rooms, in which cases we have been favored with the use of the Carnegie Library or the Normal School. The following is the list of papers given before the Branch in 1913, namely:

"Town Planning," Mr. N. Cauchon, Ottawa.

"Underground Conduit Construction," Mr. A. A. Dion, Ottawa.

"A Holiday Trip to the Panama Canal," Mr. J. Murphy, Ottawa.

"Waterways versus Railway Transportation," Mr. James White, Ottawa.

"Railroad Signalling," Mr. R. F. Morkill, Montreal.

"Street Railway Track Construction," Mr. R. M. Hannaford, Montreal

"The Coquitlam Dam," Mr. G. R. G. Conway, Vancouver

"Economic and Social Effects of Transportation," Dr. Adam Shortt, Ottawa.

"Automatic Cab Signalling," Mr. H. A. Dupre, Ottawa.

"Economics of the Panama Canal," Mr. James White, Ottawa.

Many of the above addresses were illustrated by lantern slides, and, as has already been stated, all were well attended, the average number lately present being close to one hundred, several of the audiences containing a fair proportion of ladies. The Meetings are held on the first and third Thursdays of each month throughout the winter season, namely from October to March inclusive.

Our Managing Committee meets regularly at 1 p.m. on the first Monday of each month, with special meetings as are from time to time found necessary.

Entertainment.—The Entertainment Committee this season organized for the Branch a most delightful Dinner, held on December 4th at the Chateau Laurier, one hundred and fifteen being present. As a further means of promoting mutual acquaintance among our members a system of monthly lunches has also been inaugurated.

Library.—This is gradually working into fairly good shape, the Branch having been the recipient of quite a number of books, to the donors of which we are much indebted, and the Reading Room being equipped with all the more prominent engineering magazines.

Rooms.—These remain as heretofore, because, while it is fully recognized that they are not entirely suitable for our purpose, our funds have not permitted us to contract for larger premises. It is hoped, however, that we will not only be able to get larger and better quarters in the near future, but also to equip them with a lantern, blackboard, etc.

In the meantime we are under many obligations to the authorities of the Normal School and Carnegie Library for having so kindly loaned us their meeting rooms when ours were inadequate to hold our audiences, to the Conservation Commission for the frequent use of their lantern, and to the Ottawa Electric Company for special services from which to operate it.

Finances.—The furnishing of our rooms has, up to the present, made serious inroads into our income. but we are now substantially clear of that account, and so expect that in the near future we will be able to provide somewhat more liberally for some other pressing necessities of the Branch.

American Society of Civil Engineers.—As you are aware, the above Society honoured Ottawa by making this City the meeting place for their 1913 Summer Convention. Through the energy of a Committee, of which Mr. C. H. Keefer was Chairman and Mr. S. J. Chapleau, Secretary, the local members of the American Society and the Ottawa Branch of the Canadian Society, assisted by very kind and generous support, financial and otherwise, from the Dominion Government, and by many private contributions, were able to provide what was universally conceded to be most excellent entertainment for the four hundred odd members and guests of the American Society who came to the Convention.

All of which is respectfully submitted:

GEO. A. MOUNTAIN, Chairman; A. B. LAMBE, Sec.-Treasurer.

Ottawa, January 10th, 1914.

QUEBEC REPORTS PROGRESS

The Council of the Quebec Branch of the Canadian Society of Civil Engineers presents the following report on the work of said branch during the year 1913:

Roll of the branch:—At present, the membership stands as follows: Members, 20; Associate Members, 38; Associates (branch), 2; Juniors, 12; Students, 23; Total, 95.

Annual Meeting:—The Annual Meeting of the Quebec branch was held on January 20th, 1913, under the Presidency of Mr. L. A. Vallee. The following officers were elected for the year 1913:—President, A. R. Decary; Secretary, A. Amos; Councillors, J. F. Guay, S. S. Oliver and H. Ortiz.

The past-presidents are A. E. Doucet, P. E. Parent and W. D. Baillarge.

Meetings:—The Quebec branch held 10 Business Meetings during the year 1913. Papers, etc., submitted by the Council of the Society and by the different branches were discussed. The proposed amendments to the By-law No. 8 were unanimously disapproved by the Quebec branch. This branch is of the opinion that the Annual Meetings of the Canadian Society of Civil Engineers should be held at its Headquarters. One conference on Good Roads and Road Construction was made by Mr. Gabriel Henry, Chief Engineer of the Provincial Department of Highways. This conference was most interesting and greatly appreciated; the president in proposing a vote of thanks to Mr. Henry, expressed the desire that the example given by this gentleman should be followed by all the members of the Quebec branch.

A. R. DECARY, President; A. AMOS, Secretary.

Quebec, January 17th, 1914.

TORONTO HELD ANNUAL MEETING ONLY

The executive of the Toronto Branch begs to present herewith the Annual Report for the year 1913. The services of a very active and able worker in the interests of the Society were lost when Mr. Parker Kemble left last February to take up his residence in Cincinnati, Ohio. He was on the Executive of the Branch and it was due to his efforts that our Library is in its present satisfactory condition.

A card index has been prepared, under the direction of the Library Committee of the Engineers' Club, of the combined libraries of the Toronto Branch, The Association of Ontario Land Surveyors, and the Ontario Association of Architects. These books are all located at the Engineer's Club and will by this means be accessible to all members of the three societies. Reference is also made on the cards to technical books on the shelves of the Toronto Reference Library and of the University of Toronto Library, so that excellent opportunity is afforded for consulting the authorities on almost every subject.

The membership of the Toronto Branch this year is as follows: Members, 42; Associate Members, 102; Associates, 8; Juniors, 28; Students, 35; Total, 315.

These figures represent the names on the roll in October 1913, and show an increase over the figures for 1912 of 16 corporate members, 1 associate and 6 juniors, and a decrease of 8 students.

This last figure is very much to be deplored in Toronto, where 100 new men are registering in Science each year, and the present Executive begs to suggest to the officers for the following year that some special means be adopted for reaching the younger men, and interesting them in the work of the Society. The formation of an Association of Students, as is done in connection with the Institution of Civil Engineers, would, no doubt, serve this purpose. Papers could be read by the students and trips of inspection made that would prove to be of great interest and benefit.

The lack of interest in the meetings by the members has been responsible for the fact that no papers were read before the Branch this year, and it is hoped that papers of sufficient interest to attract a good attendance at the meetings in the coming year will be secured. The officers for the year 1914-15 are: Chairman, A. F. Stewart: Hon. Sec.-Treas., J. S. Galbraith: Executive Committee, J. G. G. Kerry, C. H. Mitchell, Prof. P. Gillespie and E. A. James (ex officio).

Respectfully submitted,

E. A. JAMES, Chairman; A. B. GARROW, Hon. Sec.-Treas.

Toronto, January 20th, 1914.

VANCOUVER DID GOOD WORK

The present membership of the Branch is 146, distributed as follows: Members, 42; Associate Members, 74; Associates, 1; Juniors, 11; Students, 18.

During the year the Branch has held twelve meetings besides the meetings of the Convention of the British Columbia Members, held here on the 12th and 13th December. The following papers were read:

"The Pulp and Paper Industry in B. C.," by C. H. Vogel.

"The Burrard Inlet Joint Sewerage Scheme," by A. D. Creer,

"The Outlook for Mining in B.C.," by C. E. Cartwright.

"Some Public Works and Explorations in B.C.," since 1880. by F. C. Gamble.

"Modern Methods in the Manufacture of Portland Cement," by H. K. G. Bamber.

"Coquitlam-Buntzen Hydro-Electric Development." by G. R. G. Conway.

"Stave Falls Hydro-Electric Development," by R. F. Hayward

At the meeting of January 20th, the following officers were elected: Chairman, G. R. G. Conway; Vice-Chairman, L. G. Robinson; Secretary-Treasurer, F. P. Wilson; Executive, C. E. Cartwright and W. A. Clement; Auditors, A. D. Creer and H. P. Archibald

At the meeting of April 21st new by-laws were adopted. The by-laws increased the Executive Committee from five to seven, the date for the election of officers was changed to May, the retiring officers to hold office until the opening meeting in October. Messrs. C. G. DuCane and A. D. Creer were elected to fill the vacancies on the executive, and it was decided that the present officers should hold office until October, 1914.

The second annual dinner was held at the University Club on March 29th. About one hundred and ten members and guests were present. During the summer months, the following excursions were arranged by the branch, and many of the members attended: May 10th, to Coquitlam Dam, through the courtesy of the Vancouver Power Co.; June 6th, Special train over Saanich Railway, provided by the couetrsy of the B. C. Electric Railway, to Bentwood Bay, where the Steam Turbine Plant was examined, and to Bamberton where the members were shown over the new

plant of the Associated Cement Co., through the courtesy of Mr. Bamber, Managing Director of the Company; July 12th, to the Stave Falls Power Plant, through the courtesy of the Western Canada Power Company; Sept. 27th, to the Lake Buntzen Power Plant, by the courtesy of the Vancouver Power Company.

Yours faithfully, J. R. GRANT, Acting Secy.-Treas.

Vancouver, December 31st, 1913.

VICTORIA MEMBERSHIP GROWING

During the past year our Branch held 10 meetings with an average attendance of 18 and the following papers were read, viz.,

February 13th. "Some Engineering Works in B.C." (first section). Illustrated with lantern slides. F. C. Gamble, Vice-President.

November 13th. "Some disregarded stresses at joints and ends of steel in reinforced concrete construction." H. A. Icke.

December 11th. "A cellular method of vibrated reinforced concrete construction." J. B. Holdcroft.

Our membership increased from 62 to 82 but owing to the removal of 2 corporate members from our district, the net total stands at 80, distributed as follows: Members, 16; Associate Members, 29; Juniors, 8; Students, 4; Assoc. of Branch, 23; Total, 80.

All our Branch Associates are engineers who have applied for admission to Can. Soc. C. E. At the annual meeting held on December 11th the following officers were elected for 1914:

Chairman, F. C. Gamble (re-elected); Vice-Chairman, D. O. Lewis; Treasurer, A. E. Foreman (re-elected); Secretary, R. W. Macintyre (re-elected); Executive, the above officers with L. W. Toms and E. H. Harrison; Auditors, H. A. Icke and F. A. Richardson

With a view to developing the social side of the profession, receptions are being held in the Club rooms during the winter months, and attended by members and ladies. The year's programme closed with 2nd annual convention of B.C. members in Vancouver on December 13th. It is our intention to keep a register of all engineers belonging to the Branch who are available for employment, giving record and qualifications in each case. From this a list will be compiled and forwarded to the Provincial Government and municipal bodies in B.C.

Respectfully submitted,

R. W. MACINTYRE, Secretary.

Victoria, January 1st, 1914.

E.E. AND M.E. SECTIONS AT WINNIPEG

The Manitoba Branch of the Canadian Society of Civil Engineers begs to submit the following annual report for the year 1913. The officers for the year 1913 were as follows:

Chairman, J. G. Legrand; Executive Committee, W. A. Duff, D. A. Ross, W. L. MacKenzie and Frank Lee; Secretary-Treasurer, E. Brydone-Jack.

Meetings.—The following papers were read and discussed at the regular meetings of the Branch:

"Some Facts Concerning the Panama Canal," by J. G. Sullivan.

"The Use of Asphaltum in Protecting Levees and Railway Embankments," by Mr. Percy.

"The Auxiliary Steam Plant of the Winnipeg Electric Railway," by D. A. Ross.

"Steam Power Plant for Mechanical Department Yards at Divisional Points," by H. Lorimer.

The attendance at these meetings averaged about thirty. There is a total membership of the Branch of two hundred and eighty-three, classified as follows: Members, 33; Associate members, 101; Associates, 1; Juniors, 9; Students, 89; Local Associates, 50;

At the first of the year an electrical section of the Branch was formed which held meetings independently of the regular meetings of the Branch. At these meetings the following papers were presented.

"Physical Characteristics and Source of Illumination," by E. P. Fetherstonhaugh.

"Engineering Aspects of Illumination," by J. G. Glassco.

"Economics and Aesthetics of Illumination," by H. N. Ruttan.

"Recent Developments and Electrical Operation of Coal Docks" by F. H. Farmer.

"The Diesel Crude Oil Engine," by C. F. Bowring.

"Electric Heating from the Economic Stand Point," by Wm. Aldridge.

"Underground Cables," by M. B. Stewart.

"Comparison of British and Canadian Practice in the Distribution of Electrical Energy," by E. V. Caton.

There was a demonstration of resuscitation from electrical shock given by Mr. Aldridge at one of the meetings.

A mechanical section of the Branch was also formed at the end of the year, but no meetings were held prior to December 1st, 1913.

The Branch has co-operated with the Western Canada Railway Club and secured a room in the Industrial Bureau Building, where the members can have access to engineering periodicals, and where the nucleus of a library is being established.

At the annual meeting held on December 4th, the following officers were elected for 1914: Chairman, E. Brydone-Jack; Executive Committee, Frank Lee, W. L. MacKenzie and D. A. Ross; Secretary Treasurer; G. E. Bell.

The annual dinner was held on December 16th, 1913, in the Fort Garry Hotel, at which about ninety members and guests attended. The treasurer's report showed a balance in hand at the end of the year of $645.89.

Yours truly,

G. E. BELL, Secretary-Treasurer.

Winnipeg, January 7th, 1914.

The report of the Quebec Branch was the first on the list. The Secretary presented the report, which was received and adopted.

Mr. Leofred, in seconding the motion that the report be adopted, said he regretted there were no officers of the Quebec branch to read the report.

The report of the Ottawa branch was then submitted to the meeting by Mr. Dick. It was proposed and seconded that this report be received and adopted.

The Secretary then read the report of the Kingston branch. A remark was made as to whether a branch of this kind is doing enough work to warrant their receiving back a part of their funds.

Mr. Coutlee strongly opposed such criticism of these smaller branches or suggestions that they should be cut off, but that wherever there was a number of men in a branch of the Society, it was always best to give its members the benefit of that branch's work and the facilities at the Society's disposal. He did not think that any branch should be cut off under any pretext whatever.

The next report was from the Toronto branch and was read by Mr. J. S. Galbraith, the newly elected secretary-treasurer, in the absence of the chairman and the secretary for 1913.

Moved by Mr. T. C. Irving, Jr., and seconded by Mr. C. H. Mitchell, that the report be received and adopted. Carried.

It was then remarked, by way of criticism, that, according to the report the Toronto branch had hardly done sufficient work during the year to warrant giving them $575 out of the funds. According to the report all they had done was to elect officers and compile a card index. Mr. T. C. Irving, as an officer of the Toronto branch last year, ex-officio, stated that the branch was not in the position of the Ottawa and other branches. The Toronto branch did not have to have house committees, or an annual dinner, for the reason that the Engineers' Club had an annual dinner. Regarding the library, of which so little is said in the report, he regretted very much that the chairman had not seen fit to elaborate on the books added to the library. He thought they had in the Toronto branch the latest and most modern books on engineering.

Mr. Leofred remarked that the branches would undoubtedly show better results a little later on. Patience should be displayed.

Mr. Irving, then stated that it was proposed next year to build a new Engineers' Club in Toronto, and that money would likely be needed to be spent by the Toronto branch on the library and in arranging to make the headquarters of the branch in the new Engineers' Club. He remarked that the branch, in his estimation, should be congratulated instead of being criticized upon its large surplus.

Mr. Chipman rose to defend the Toronto branch. It had not, perhaps, given as good an account of itself as the Society had a right to expect, during the last few years, but there had been disadvantages in Toronto. With respect to finances it was his opinion that each branch had a right to spend its money in any way it deemed best fit in accordance with the by-laws of the Society. Toronto was husbanding its resources with a view to co-operating in the future with the Engineers' Club.

Prof. Haultain remarked that the Toronto members regretted the neglect which was apparent, but that they were "turning over a new leaf." There had been 44 members at the last annual meeting—more than at any previous annual meeting in years, and more, in fact, than the total attendance at the past several annual meetings. Interest was being warmly renewed and they were thankful to have $575.00 to begin with.

Mr. Harkom thought that there was one point which had not been fully considered, and that was the encouragement of the branches all over the Dominion. He strongly recommended that the Society should do all in its power to encourage its branches.

The Secretary then read the report of the Manitoba branch, which was duly accepted.

After the reading of the reports from the Calgary and the Vancouver branches, it was duly proposed and seconded that they be received and adopted. Carried.

The Secretary, after reading the report from the Victoria branch, said that in the matter of the last two reports he had in hand a somewhat voluminous report of that convention for the benefit of this meeting, and desired to know if those present would like it read.

Mr. Rust said he thought there was hardly any necessity, as it would take too much time. He knew they were very successful and very interesting, he having been present at the convention.

After much discussion an original motion respecting the report of this convention as well as the several amendments, were withdrawn, and it was eventually accepted, on the motion of Mr. Johnson, that the report be read Wednesday afternoon at 3 o'clock.

The presidential address was then delivered, the Secretary assisting because Mr. Johnson had a severe cold.

The address was received with much applause and appreciation, which was suitably acknowledged by the President.

PRESIDENTIAL ADDRESS

Remarks of Retiring President Had to be Brief Unfortunately Owing to Bronchial Attack

Gentlemen,—It is decreed by custom that a retiring President of the Society shall make an address. A good number of my predecessors in the office, following what was probably to them the line of least resistance, have given you a paper on some engineering topic.

I considered following this course, but abandoned the idea for the reason that it seemed impracticable to treat in a satisfactory way a problem in bridge construction without the aid of diagrams and lantern illustrations.

A general review of the progress made in the different fields of engineering, or a review of the more important works that have been carried out in Canada, are both beyond my limitations. I shall, therefore, speak to you only on Society matters, and I am the more ready to do this for the reason that at our last annual meeting and later in published correspondence, complaint was loudly voiced that the Society was not doing enough for its members, and the Officers and Council of the Society did not escape serious criticism.

The objects and purposes of the Society are in its Charter stated to be, "to facilitate the acquirement and interchange of professional knowledge among its members."

It seems evident that this basic purpose of the Society can best be achieved by having enrolled in its membership a large proportion of the able and active engineers of the country, by the interchange of thought and of experience at its meetings and particularly by the reading, discussion and circulation of papers on important and interesting works or investigations.

The Society was organized 26 years ago by a few of the then prominent engineers of Eastern Canada. The movement met with the enthusiastic support of most of the Engineers then in active practice, and at the time of the first annual meeting in 1888 there were 225 members and 65 associate members, or a total corporate membership of 290. From that date the number has steadily increased until we have at present the time 622 members and 1,313 associate members, or a corporate membership of 1,935. A few of these members, less than 40 in all, have come in under the Quebec Act, and a few more in this Province have joined almost under compulsion because of the Act, but the large majority have joined without pressure and without special solicitation, evidently because they considered membership in the Society beneficial and that to belong to it gave them a standing in the profession and in the community that otherwise they would not have.

While the growth of the Society in numbers has been very satisfactory, there has been no corresponding growth in the enthusiasm of its members, as evidenced by attendance at the meetings, by the preparation and contribution of papers, or of discussion on the papers submitted, but rather the reverse. The first eight years of the Society's history there was an average corporate membership of 378 and an average of 13 papers per year were submitted, read and published. The last 18 years the average corporate membership has been 921 and the average number of papers per year, again 13. In the first 8 years a paper was presented by one member out of 29. During the last 18 years we have had one paper for each 71 members. During the last 3 years we have had one paper for each 132 members.

Real enthusiasm cannot perhaps be worked up to order, but we can all do our duty, and I would call your attention that following our election we have all agreed "to promote the objects of the Society so far as in our power", and "to present to the Society an original communication" (meaning a paper) "or some scientific work for the library."

I fear a great many members have so far overlooked this pledge and hope for a great increase in the number of papers in the near future. I would particularly urge that the younger members prepare and submit papers describing the work on which they are engaged, or of which they have good knowledge, and this as much for their own sake as for the good of the Society, for the presentation of a paper of merit will go a long way toward giving them a professional standing they cannot well gain in other ways. A good paper need not necessarily be based on a large and important work, or even a successful one, for failures are often the source of very valuable information.

In connection with the complaint that the Society has not been doing enough for its members, it will be interesting to inquire what other Societies of similar nature are doing for their members. The Societies which at once come to mind for comparison are the Institution of Civil Engineers of Great Britain and the American Society of Civil Engineers. Both of these Societies have been long established and have a large membership, both have accumulated valuable properties and have annual surplusses of revenue over ordinary expenditures greater than our entire gross revenue. With ample means at their command and with able management it would seem that we may reasonably expect to find these Societies rendering their members every obvious useful service.

The British Institution of Civil Engineers publishes and distributes to its members four volumes per year, each volume containing the reports of the meetings that have been held since the last issue and a list of those admitted as students or as members, or transferred from one class to another. The papers read at the meetings and the oral and written discussions thereon are published, as well as a number of "selected papers" which apparently have not been read and discussed but are considered worthy of publication. A good part of each volume is devoted to "Abstracts of Papers in Scientific Transactions and Periodicals," a typical volume devoting over 100 pages to short reviews of 170 selected articles. The abstracts in the volume examined bear the initials of thirteen different reviewers, and this suggests that the work is not done by the Secretary's staff, but by writers familiar with engineering subjects, specially engaged for the work.

The American Society of Civil Engineers publishes in pamphlet form ten volumes of proceedings per year, each containing brief reports of the meetings of the Society and of the Board of Direction, which corresponds to the Council of the Society, the names of members elected and transferred from one class to another, a list of additions to the library with a synopsis of the contents of the more important books and gives a list of recent engineering articles of interest, reviewing for this purpose more than 100 publications. Each volume also contains a number of original papers with the discussions thereon.

It will be seen that both of these Societies not only publish their transactions more frequently than our Society, but go to considerable expense in keeping their members advised as to recent engineering literature.

Aside from their activity in this direction I am unable to find that these older and larger Societies do their members any service which we are not endeavoring to do for our members, and it is to be borne in mind that these Societies are financially able to do for their members every useful service considered desirable.

Neither of these Societies has branches or divisions corresponding to our own, though there are a number of local "Associations of Members of the A.S.C.E." in various parts of the United States which hold regular meetings and read and discuss papers as do our Branches. These associations have Charters approved by the Parent Society but receive no financial assistance from it.

Apparently the only useful suggestions we can get from the practice of these two older Societies are the desirability of more frequent reports to the membership, and keeping the members advised of current engineering literature, the latter a matter of considerable expense which the finances of the Society have not heretofore permitted.

The criticisms made at our meetings and in correspondence have as a rule been very general and with few specific suggestions. There seems to be a feeling that the officers and the Council are not doing all they should, that they are not keeping the members well posted, that the Council is not fairly representative of the different districts, and that it would be well if its members were younger and more enthusiastic and if they served shorter terms.

The remedy for these faults, if they exist, is in the hands of the membership at large, for it can make and alter By-laws, can designate the Nominating Committee, and can elect Councillors, and through them control the policy of the Society.

Some of the members, I believe a very small proportion evidently feel strongly that the Society should interest itself in the troubles of its individual members, with the Municipalities and Corporations employing them, and particularly that the Society should take active steps to keep out so-called Alien Engineers, and conserve Canadian business for the members of the Society.

I can conceive of no course so sure to discredit and disrupt the Society as to adopt Labor Union methods,and interfere in the disputes of engineers with their employers.

I agree that Canadian work should as a rule be done by members of this Society, but pressure to this end can best be exerted by the local members and branches, and I feel strongly that except in connection with works handled direct by the Dominion Government, the Society should not officially intervene.

On the whole I consider the complaints that have been made to have little support in existing conditions and believe that the Society has in the past done for its members about all that could reasonably

be expected. I do think, however, that the members of the Society have in great measure failed to do for the Society and for themselves all they should and believe they can hereafter, by taking a more active interest in it, by contributing and discussing papers, by attending meetings of the Society and Branches, by paying more attention to the applications for membership and advising the Council in regard thereto, and in other ways, make the Society of use to themselves and at the same time promote its interests.

In conclusion I wish to point out one way in which it may be the Society can be of great use to members without engagements or desirous of changing their employment.

The suggestion comes through the Engineering News of the 21st of August last, which, in an article headed "Making Membership in an Engineering Society a Tangible Asset," states that the "Junior Institution of Engineers" in England, a Society of which I have no special knowledge, has undertaken the establishment of a permanent Engineers' Register which will give a complete record of the professional career of every member, the purpose being to form a sort of clearing house to assist members in improving their positions by systematically recording the particulars of their experience and technical training, and by effecting the introductions to engineering employers of members who possess such qualifications as may fit them for vacant positions. To establish and maintain a Register of this nature would involve considerable expense, and would require the hearty co-operation of all members. I think, however, the suggestions well worthy the serious consideration of the incoming Council.

(NOTE:—The attention of members of the Society is respectfully called to the fact that "The Information Department" of The Canadian Engineer has, for five years past, kept the very kind of records advocated by Mr. Johnson. The complete record of any engineer who cares to supply the necessary data concerning himself, is kept on file. This file is open for inspection to any employer whose desire to add to or change his staff is bona-fide. Great care must be exercised not to allow the personal data in this file to be shown indiscriminately. Through this Information Department upwards of three hundred engineers have secured or changed positions.

Should the incoming Council adopt Mr. Johnson's suggestion, and appoint a manager to conduct such a file as a department of the Society, The Canadian Engineer hereby offers to present to the Society the entire records of its Information Department, upon the assumption that the work, if undertaken by the Society, would be prosecuted with greater thoroughness than is possible for any technical paper.—EDITOR.)

WEDNESDAY AFTERNOON SESSION

The meeting opened at 3 o'clock with a good attendance. Mr. Johnson was in the chair.

The report of the Convention of the British Columbia branches was read in part by Prof. McLeod, bringing out the fact that the members of that province were not inclined to concur in spirit with the action of the Council in the matter of sending out information concerning the vote on by-laws.

The President explained this particular point to have arisen from the feeling on the part of the Council that some communication on its behalf should accompany the by-law which was being mailed to the members, relating to the establishment of a provincial division of the Society in British Columbia.

At the September meeting at which the by-law, proposed by the Council, had been brought up, there had been no difference of opinion concerning it excepting the question of financial aid from the funds of the Society. The form of the by-law was not objected to insofar as it incorporated the proposed association with the existing branches. The underlying idea was that the association thus formed should not supercede the branches but that the Society should communicate more directly with the branches than with the association.

The by-law which the British Columbia branches submitted later differed from that proposed by the Council, the British Columbia members apparently being under the impression that the Council's by-law rather ignored their wishes.

Mr. Johnson thought that, when the Council was considering the submitted by-law, it might possibly have been adopted had it not been for the fact that the Council's by-law had been passed by a large meeting. It was felt that the decision of this larger meeting should not have been upset by the smaller meeting.

As far as the Council was concerned, therefore, it had no alternative, said Mr. Johnson, but had sent out both by-laws. As they covered the same ground, it was deemed essential to call the attention of the members to the fact that they were by-laws dealing with the same subject. A clause inserted in the communication for this purpose had—in the opinion of the British Columbia members—influenced voters in favor of the Council's by-law and against their own. Hence their objection.

This situation was the subject of discussion during the greater part of the afternoon. At the outset several members inquired why the whole communication had not been read by the Secretary on Tuesday. Mr. Kennedy replied that it was largely the proceedings of the convention of the Vancouver and Victoria branches, containing papers upon such subjects as "The Training of Young Engineers," and "The Question of a Common Level Datum," and other matters quite removed from the subject under discussion. They were not read, because it was desired to confine the discussion to the main subject.

The action of the Council, in inserting the explanatory paragraph in the communication which had been sent out, was upheld. The paragraph itself was endorsed in sentiment by the members. The discussion reverted to conditions peculiar to the western provinces, and the importance of recognizing that the western members had a better conception of these conditions than eastern members, generally speaking, could possibly have. It digressed to the matter of qualification of candidates for membership, whereupon the President observed that the Council would be greatly assisted in the passing of applications by receiving whatever information members might be able to furnish regarding candidates. Several members emphasized the fact that the Council had to rely largely upon such assistance; naturally having no personal acquaintance with many of the applicants.

Returning to the chief subject under discussion, it was maintained that the Society should do all it could to further the interest of all its branches, and that those most distant from headquarters should particularly be given all possible co-operation. The efforts to restrict the membership to well qualified men were heartily commended, and it was recognized that the advice of members residing in the same province as the applicant is most valuable in this regard.

The widely scattering discussion experienced a concentrating effect from a resolution submitted by Mr. Kerry, which was afterwards amended by Mr. Harkom's motion, seconded by Mr. Dietrich, and adopted. (Upon further consideration, however, it was felt that the wording of this amended resolution conveyed an impression different than anything intended, and it was rescinded at Thursday morning's meeting. A new resolution with better phraseology was substituted.)

A communication from the Manitoba branch was the next subject for consideration, but discussion was postponed by motion.

Complying with a request made at the Tuesday morning session for further particulars of arrears fees outstanding at the end of 1913, the secretary presented the following information:

"For 1913 the unpaid subscriptions amounted, for members $1469; for associate members, $4,456; for associates, $85; for juniors, $530; for students, $384. Total, $6,944"

"Arrears for 1912 and previous years, members, $964; associate members, $3,907; associates, $125; juniors, $403; students $395. Total $5,794.

"Sum total of outstanding arrears is $12,709. It was estimated by the auditor that these were worth $5,000 as indicated in the financial report submitted Tuesday.

"The statement which should have accompanied the report as to the number of members was as follows:

"Quebec, 40 corporate members, 9 non-corporate members.
"Ottawa, 156 corporate, 45 non-corporate.
"Kingston, 14 corporate, 6 non-corporate.
"Toronto, 128 corporate, 81 non-corporate.
"Manitoba, 130 corporate, 80 non-corporate.
"Calgary 30 corporate, 5 non-corporate.
"Vancouver, 114 corporate.
"Victoria, 40 corporate, 8 non-corporate.
"Total, 638 corporate, 248 non-corporate."

Mr. Jamieson remarked that the statement showed a state of affairs that should not exist. It was a large amount of arrears. This same question had been brought up from year to year, and instead of improving it was getting worse. It seemed that members were carried on the list long after the age limit had expired.

The President suggested that if he referred to the report of the Council it would be found that 437 students were dropped from the list during the past year because of over age or non-payment of dues. Mr. Brayley suggested that the matter be taken up by the finance committee to see if there was room for improvement.

Upon motion by Col. Anderson, the meeting was adjourned.

EXCURSION TO BRIDGE WORKS

The excursion to the St. Lawrence Bridge Company's shops at Rockfield was attended by about 250 of the members, special cars for the trip having been placed at the disposal of the visitors by the Montreal Tramways Company.

Upon arrival a thorough inspection of the plant disclosed many very interesting features in its construction and in the facilities to be seen there for the fabrication of the superstructure of the Quebec bridge.

After completing the tour through the shops a luncheon was served by the Company in the Templet Shop, at which a number of addresses were given.

THURSDAY MORNING SESSION.

The President called the meeting to order at 10.20 a.m.

It was decided to re-consider the resolution submitted by Mr. Harkom at the Wednesday afternoon session, and after thorough reconsideration it was rescinded.

Mr. Kerry submitted the following resolution to take its place:—

"That this meeting has considered the resolution of the British Columbia Branches, objecting to the action of the Council in commenting on a proposed amendment to the By-laws, and is of the opinion,

"(1) That the Society welcomes any expression of opinion or advice from the Council concerning matters of general import with which the Society proposes to deal.

"(2) That it suggests that such opinion or advice be printed independently of the ballot to which it refers.

"(3) That the incoming Council be entrusted to further deal with the development of the branch and divisional system as part of the organization of the Society."

Mr. Ross, in seconding the motion, observed that it contained the substance of the previous resolution and in much better shape. Carried.

The Secretary read the report of the Gzowski Medal Committee, which was received and adopted. He then read the report of the Examiners on students' papers. The meeting agreed to award two prizes in the General Section.

The Secretary next submitted the report re the amendment of By-laws.

The amendments proposed with regard to By-laws Nos. 9, 20, 36 and 51 of the Society were adopted. The amendments proposed with regard to By-law No. 8 of the Society were rejected. The new By-law No. 56, proposed by the Council and by certain members resident in British Columbia, did not have the necessary two-thirds majority vote to carry. The existing By-law No. 56 to be renumbered 57 was adopted.

The Secretary read the report of the Scrutineers and election of officers and members of the Council.

The officers elected to serve on the Council are as follows:

President:—M. J. Butler, C.M.G., Montreal.

Vice-President:—R. A. Ross, Montreal.

Councillors:—Representing District No. 1.—Montreal and district within 25 miles:—J. M. R. Fairbairn and H. M. MacKay, Montreal.

Representing District No. 2.—Newfoundland, Nova Scotia, Prince Edward Island, New Brunswick and the United States:—R. McColl, Halifax.

Representing District No. 3.—Province of Quebec (outside of the Headquarters district), countries outside of Canada, Newfoundland and the U.S.A.:—A. R. Decary, Quebec.

Representing District No. 4.—Ottawa and the Province of Ontario east of and including Lindsay:—R. F. Uniacke, Ottawa.

Representing District No. 5.—The Province of Ontario west of Lindsay:—W. A. Bucke, Toronto.

Representing District No. 6.—The Provinces of Alberta, Saskatchewan and Manitoba:—F. Lee, Winnipeg.

Representing District No. 7.—The Province of British Columbia:—G. R. G. Conway, Vancouver.

The report was received and adopted.

At this juncture the retiring President, Mr. Phelps Johnson, rose and surrendered the Chair to the new President, Mr. M. J. Butler. There was loud applause on Mr. Butler's taking the chair. He remarked that he could only faintly express his appreciation of the very great honor conferred on him by asking him to succeed Mr. Johnson, and to accept the highest position in the Society.

The President then announced the next in order of business to be the election of members for the nominating committee. The Secretary read the results of the ballots.

The President inquired whether there was any further business to bring before the Society.

Mr. R. B. Rogers announced that he desired to bring before the Society a matter referred to in the late president's address, reading as follows:—"While the growth of the Society in numbers has been very satisfactory, there has been no corresponding growth in the enthusiasm of its members, as evidenced by attendance at the meetings, by the preparation and contribution of papers, or of discussion on the papers submitted, but rather the reverse."

Mr. Rogers thought that cognizance should be taken of this reference. It was a matter of vital importance, and should be thoroughly looked into. He moved that a committee be formed to consider means to increase the enthusiasm of the members in general throughout the Society, the committee to report in six months to the Council; and that their report be printed and sent to the members, the matter to be brought up at the next annual meeting.

This motion was seconded by Mr. Kennedy.

Mr. Francis, speaking at length against the motion, said he was not aware of such lack of enthusiasm. On the contrary he thought that the members were as enthusiastic as they ever were, and that he was rather surprised to hear the matter brought up.

A lengthy discussion followed, and in which many of the members, including the Chairman, took active part. Many suggestions as to the means for remedying the condition of affairs alleged by Mr. Rogers were offered. Mr. Odell very aptly remarked that he would suggest that each member constitute himself into a committee to enthuse himself! (Laughter and applause!)

The Chairman ruled that the matter be referred to the incoming Council and that it be left with them to appoint any necessary committees to deal with the question.

Upon motion, the meeting was adjourned.

HYDRO-ELECTRIC POWER-STATION AT CHESTER, ENGLAND.

A novel hydro-electric station was not long since put in operation on the River Dee at Chester, Eng. Nearly 1,000-h.p. of electrical energy is being derived from a waterfall whose maximum head is 8 feet. The station was built by the Corporation Electricity Supply Department, who had to face the fact that twice a year at least the tidal bore of the Dee would reduce the head of water to only a few inches. However, upon working out the prospects of the scheme, it was found not only that the tidal bore exerted its influence at midday and midnight, times when electricity is little in demand, but also that the available power was least during the summer months, also a time when the demand for electric power is lightest.

The station is built on the site of the old Dee mills, which existed since Norman times until 1910, when they were finally purchased by the Corporation and pulled down. It was thought that the usefulness of the water at the weir for power purposes was at an end; but, upon the suggestion of the city electrical engineer, the possibility of using the water-power for electricity supply was investigated.

The old weir is built diagonally across the river at the east side of the old Dee Bridge, and practically forms a channel to conduct the water to the power-station; and, in this channel, sluice-gates and a strainer-rack have been placed. Below the weir the river is tidal, so that a specially-designed plant has had to be adopted capable of working efficiently over a wide variation of head and, consequently, of speed. The amount of power developed at any time depends upon the height of the river above the weir, which is, of course, a function of the rainfall, and the height below the dam, which depends on the state of the tide. It is calculated that these two factors will give average heads as follows:—

	Feet.
December	4.5
January, February, and March	6.25
April, May, October, and November	7.5
June, July, August, and September	8.75

The Electricity Committee has undertaken that in the working of the installation the water in the river above the weir shall not be lowered more than 6 inches below the mean height of the weir.

The new station, which has already been constructed, has been furnished with an installation of machinery, which, it is estimated, will yield about 1,250,000 units a year at a cost including capital charge of somewhat less than .3d. (or 3-5 of a cent) per unit.

A higher horse-power than that developed by any other vessel in the world will be one of the features of the new battle cruiser "Tiger," which has been launched at Clydebank, Scot., recently. It is unofficially stated that the engines will develop shaft horse-power, which means a speed of at least 31 knots.

A METHOD OF STRENGTHENING ROOF TRUSSES.

A NOVEL method of strengthening the roof trusses of a large public building was recently carried out satisfactorily by a Toronto engineer. The trusses, which are Howe trusses with wood chords and diagonals, and steel verticals, were of fairly good general proportion and make-up. The connections were inadequate, however, and the trusses had sagged considerably. The problem was to effect repairs in place, without disturbing either the ceiling, hung from, and partly resting on, the bottom chords, or the roof trusses which rest directly on the top chords.

The trusses (see Fig. 1) are 60 feet in length with depth of 8 feet centre to centre of chords. Both top and bottom chords are of uniform section throughout, the top chord being 7½ x 11½ in. and the bottom one composed of 4 pieces 1¾ x 12 in. The bottom chords are not spliced and have in some places two joints close together, so that the net value of the bottom chord (and this is near the centre of the truss) is not more than 2 pieces 1¾ x 12 in., equal to 42 sq. in. The diagonals are 6 x 8 in. throughout and the verticals are of round rods, 1½ in. diameter, not upset. There are 8 panels, but only 3 loading points located at the centre and at quarter-points. At the quarter-points the rods project downwards, through the bottom chord, to which they are not fastened, to carry lower side panels of the ceiling. At loading points there the 8 x 8 in. posts, the rods passing through these.

Loading is on the top chord from the roof, and though apparently on the bottom chord from the ceiling joists, it was found to be carried fully by the top chord. The trusses sagged at the centre, to a maximum of 3½ in. Some of the diagonals were found loose, showing that they took no weight; the arching of the roof, tied by indirect cross joist system, evidently taking the load.

Reinforcing was effected mainly by means of two wrought iron suspender rods for each truss, the rods being 1½ in. square, with each rod in three parts, centre and two ends, attached to pins at top chord ends and held together by Cleveland turnbuckles engaging upset ends. The pins are 2 in. in diameter, with pin plates, one on each side of top chord, 10 x 12 x ½ in. The top chord is reinforced throughout by two pieces of 2 x 10-in. pine, one on each side, bolted on by means of ¾-in. through bolts, spaced, staggering about 2 ft. The bottom chords are spliced by means of 2 x 12-in. pine pieces attached with ¾ x 9-in. lag screws. The reinforcing rods take bearing at the loading points, on shoulders formed by 2 x 8-in. pine pieces, one on each side of the post. Two pieces, 2 x 6 in., one on each side of truss, form struts resisting the side thrust, due to inclination of the rods at the quarter-point supports.

The rods and other reinforcing material were put in place practically without disturbing anything, in the space between the ceiling and roof. The 6-inch play in the turnbuckle for adjustment enabled the straightening up of the trusses, i.e., elimination of sag, as far as desired.

After this was done the top chord reinforcing was completed and given good abutting joints throughout, all vertical rods drawn up tight and diagonals brought to bearing, so that, although somewhat indeterminately, both the old truss and the reinforcing system will do work, in carrying the loading.

Without prejudice, it may be said that this class of work, viz., reinforcing of a truss or other member of a structure after it proves inadequate to do the work assigned to it by the architect or builder, is not an uncommon experience with engineers. The rational method is to have a competent engineer design the structure in the first place.

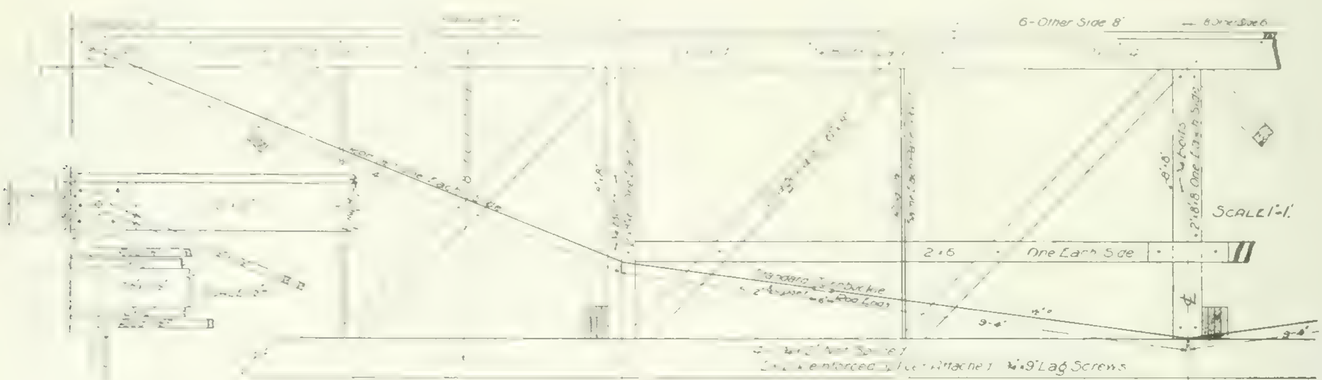

Fig. 1.

The statement of the Public Utilities Commission recently published, giving the condensed earning report of the Manitoba Government telephones for the 12 months ending November 30th, shows the revenue to have been $1,707,149.74; expenses, $1,269,909.90; net earnings, $437,239.84; interest charges, $406,975.20; and a resulting surplus of $30,264.64.

A cable sent from London to the New York Tribune not long ago reported the following in connection with a new invention in wireless science: "The newest development in wireless telegraphy was demonstrated at the exhibition of the Physical Society of London in the Imperial College of Science. This invention aims at the detection of direction from which a message comes. No one has yet discovered how to send wireless rays like a searchlight in any definite direction. They go out everywhere, but, even though they cannot be directed, it is just possible that a ship will be able to find out whence they come. This is done by a wonderful new instrument shown by the Marconi company.

According to the estimates which have been prepared by the Provincial Department of Mines, the total mineral production for the year 1913 will be slightly less than $30,000. The value of mineral products for the last year will be approximately $29,555,000, which is nearly $2,500,000 less than the production for the previous year. This decrease is due to a shortage of $1,600,000 in the coal mining industry occasioned by the labor troubles on Vancouver Island during the summer, and a shortage of about $656,000 from the metalliferous mines, due to a decrease of some $1,160,000 in the copper output and $25,000 in zinc which are, however, partly compensated for by increases in the output of gold, silver and lead.

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CONTENTS OF THIS ISSUE.

RETROSPECT OF THE 28th ANNUAL MEETING.

The attendance of members at the recent Annual Meeting of the Canadian Society of Civil Engineers was probably the most representative in its history. There were in attendance prominent engineers from all portions of Canada and not a few from across the border to the south.

There was noticeable a distinct effort on the part of the Officers and Members of Council to restrict the proceedings to matters of first importance to the profession and its development.

Of the reports submitted, the most important was that in relation to Reinforced Concrete. No final action could, of course, be taken on a first consideration of the report. It will be referred to the branches of the Society, and to the membership at large, for discussion and at the next Annual Meeting it should be in form for adoption. It will constitute an advance on the present progress of the art which all concerned will, we are assured, greatly welcome.

The most prominent feature of the meeting was perhaps an indication of the desire on the part of the Council to get into more intimate touch than has hitherto been possible with the needs of its members. The recent effort to amend the by-laws in such shape as would advance the status of the profession generally in Canada will be noticed by anyone reading carefully the general remarks in the Report of Council, and it is to be regretted that while the membership at large undoubtedly favor the proposal to establish Provincial Divisions, the circumstances referred to elsewhere intervened to prevent the attainment of that end.

The recommendation that the business meeting of the Society should be held at headquarters is doubtless one which will commend itself to the business instincts of the engineering profession, while all will heartily approve of the proposal to develop the feature of summer meetings. The undertaking to hold such a meeting on the Pacific Coast at the earliest opportunity is one which will be heartily endorsed by all the members. This excursion would follow as closely as possible the opening of one or both of the new transcontinental routes and will be held in conjunction with the Panama Exposition and the series of engineering conventions to be held in San Francisco in 1915.

While, as always occurs in healthy growing institutions, there were some minor differences of opinion which developed as between members holding different points of view, the feeling was again and again expressed of hearty appreciation of the work of the Council of the Society and its efforts towards the consolidation of the profession as a whole.

The address of the retiring President, which we publish in full on another page, deals to a greater extent than is usual with Society affairs and we commend it to all members for serious reading.

THE QUESTION OF PROVINCIAL DIVISIONS.

It will be noticed from our report regarding the result of the ballots for amendments to by-laws of the Canadian Society of Civil Engineers, canvassed at the recent Annual Meeting, that an effort to establish Provincial Divisions within the Society was not successful. This failure seems to have been due to the disinclination of the British Columbia members, who mainly advocated

the proposal, to accept the by-law in regard to Provincial Divisions drawn up by the Council. The alternative by-law submitted by the British Columbia members differed from that proposed by the Council in minor matters only, the chief of these being that the British Columbia members desired to impose a fee of $1 on all members resident in the Province.

While we do not wish to enter into a discussion as to the merits of a proposal to establish Provincial Divisions, it would undoubtedly have been an act of wisdom on the part of those desiring them to have refrained from giving the membership an opportunity to split their votes, and the first effort should have been limited to a decision as to the principle involved, leaving the adjustments of details to the future. A resolution adopted at the close of the meeting recommitted this matter to the Council, and the question will no doubt be put, possibly in a modified form, before the membership with a view to amending the by-laws at the next Annual Meeting.

LETTERS TO THE EDITOR.

Ottawa Water Supply—Reply to Mr. Pitcher.

Sir,—In your issue of January 15th Mr. F. H. Pitcher, of the Montreal Water and Power Co., argues that the City of Ottawa might better filter and pump the Ottawa River water instead of putting in a gravity water supply from the Gatineau Lakes.

Mr. Pitcher argues that a filtration plant of the mechanical gravity type can be put in for $550,000, and that by erecting this proposed plant the city would save $7,450,000 out of a proposed $8,000,000 expenditure.

Granted that he is right in his estimate of the cost of the filtration plant, his cost comparison takes no account of the cost of operation and maintenance of the proposed filtration apparatus over that of the proposed gravitation system; neither does it take account of the cost of operation, depreciation and maintenance of pumping machinery.

DONALD F. McLEOD,
Town Engineer.

New Glasgow, N.S., January 19th, 1914.

* * * *

The Billings Bridge at Ottawa.

Sir,—I read with interest the account of the proposed highway bridge for the City of Ottawa in *The Canadian Engineer* of January 29, 1914. Permit me to offer some kind criticism concerning the same.

It seems a shame to build a bridge with the steel work built to good heavy specifications and to have such a light floor slab. The floor slab is given as 4½ in. deep and apparently about a 4-ft. span.

Considering the specification of the Ontario Highway Board, which is regarded as good general practice, the slab holds good for only a 1-ton motor truck loading, if we assume that the wheel load is distributed over an area of 2 x 2 ft. (which is really too liberal an assumption). A 1-ton motor truck (Gramm) weighs 4,500 lbs., which, with the live load of 2,000 lbs., totals 6,500 lbs. The dead load is distributed equally over the four wheels while the live load is carried on the rear wheels. This gives a rear wheel load of 2,125 lbs. A 5-ton truck (not an uncommon load nowadays) gives a rear wheel load of 7,600 lbs., which would necessitate a slab of 5 in. effective depth if we assume the 2 x 2 ft. distribution, or 8 in. if we assume a distribution of 1 x 1 ft. (which is more nearly the actual condition).

The question of modern loading for highway bridges is one that demands the attention of all designing engineers. There was a time when the road roller produced maximum stresses, but to-day we have operating upon our highways many motor trucks that produce much larger stresses than the largest road roller. The bridges must be built heavy enough for these trucks or we will impose upon our country a grave barrier to progress.

A BRIDGE ENGINEER.

Toronto, January 31st, 1914.

* * * *

Inquiry re Ice Pressures, and Flow of Water in Pipes and Chambers.

Sir,—Kindly allow me through the columns of your valued paper to obtain the following information:

What is the best formula as used in modern practice where very close computation is necessary for:

(1) Flow of water in pipes of various materials as required for water supply and power development inclusive of small pipes to penstocks attaining 20 ft. in diam.?

(2) Flow of water in channels inclusive of small sewers to water conduits attaining 20 ft. diam., the latter with only the necessary head to produce full bore flow?

Ice Pressure.—Having ascertained from particular conditions existing on a river as to probable maximum amount of ice in cu. ft. which can come down in mass, also the velocity of approach:

(3) What is the formula for finding the pressure exerted per sq. ft. on a vertical surface such as a solid dam or pier? Is the centre of pressure located at the centre of gravity of ice sheet?

(4) What is the formula for the pressure against the same surface exerted during the formation of ice per sq. ft., which would be the only pressure caused by ice on a large storage reservoir or dammed lake?

(5) Must allowance be made for the total pressure exerted by a season's formation or only for amount of ice formed during the maximum period of lowest temperature prevailing?

(6) What is the crushing strength of the best average ice formed on Canadian rivers?

(7) Are there any reliable works dealing with ice pressure and where can they be procured?

Any information on the above will be deeply appreciated.

AN ENQUIRER.

Montreal, January 24th, 1914.

Concerning the annual banquet of the Canadian Society of Civil Engineers, "La Patrie," Montreal, had the following to say: "The Canadian engineers who had their annual banquet last evening are men of actions and not of words. They made this evident in their very excellent and very brief speeches. There was not one speech of more than five minutes' duration and each speech produced a better impression than the windy eloquence to which we are accustomed under similar circumstances."

FIXED CARBON TEST AS APPLIED TO ASPHALTS

SUMMARY OF ARGUMENTS PRO AND CON THAT HAVE APPEARED IN THESE COLUMNS—A LETTER FROM FRANCIS P. SMITH, PH.B., M.A.S. C.E., A PROMINENT CONSULTING CHEMIST AND TESTING EXPERT

Sir,—The extended discussion in your columns on this test has greatly interested the writer and it occurs to him that at this time a resumé of the arguments for and against this test may be of value to your readers. He considers it only fair to state at the outset that in his opinion it is purely an identification test and has nothing whatever to do with the fitness or unfitness of an asphalt for paving purposes

In order to intelligently discuss the matter, it is first necessary to understand clearly just what this test really is. In his own experience he has found that there seems to exist considerable confusion in the minds of a number of engineers on this subject. In many instances it has been confounded with the free carbon test used in the examination of coal tars, although in reality it is a totally different test. In order to clear this matter up, even at the risk of repeating much that has already been said, the writer begs to call attention to the definitions of these two terms which have been adopted by the Committee on Nomenclature of the American Society for Testing Materials. These definitions are as follows:—

Free Carbon in tars is organic matter which is insoluble in carbon disulphide.

Fixed Carbon is the organic matter of the residual coke obtained by burning hydrocarbon products in a covered vessel in the absence of free oxygen.

It is evident from the foregoing that *free carbon* exists as such in tars. It can be isolated and determined by the simple process of dissolving the tar in carbon disulphide. By this treatment the free carbon, which is held in mechanical suspension in the tar and exists as a very fine powder resembling lamp black, remains unaffected by the solvent and may be filtered out and weighed.

The *fixed carbon*, on the other hand, is determined by burning the material in the absence of air in a prescribed way and for a fixed and arbitrary period of time. The mixture of coke and ash left is then weighed and the amount of coke determined by burning it off until nothing but the ash is left. After deducting the weight of the ash, the per cent. of coke is calculated on the basis of the pure bitumen contained in the material under examination.

The coke obtained in this manner is, of course, procured entirely by burning the material and does not exist at all in the original substance. Take, for instance, any pure asphalt and it will dissolve completely in carbon disulphide. If it contained any coke, this coke would not dissolve and yet when the same asphalt is burned under certain conditions coke will be formed just as it is formed by the incomplete combustion of coal. The fixed carbon test was originally devised solely for the examination of coal and for the purpose of showing approximately what proportion of carbonaceous material available for the production of heat will remain after the lighter and more volatile hydrocarbons have been burned off. This is concededly a useful and important test for solid fuels but all modern paving specifications contain special provisions to prevent the burning of bituminous paving mixtures *so that it is hardly logical to consider them as coming under a fuel classification.*

The asphalts used in the paving industry differ quite widely in their composition and are really very complex materials containing a large number of constituents. To a large extent these constituents are the same in all asphalts but the relative proportions of them differ. These constituents may be divided into two classes; viz., impurities and pure bitumen. The impurities consist of mineral matter (sand, clay, etc.) and vegetable matter (twigs, sticks, etc.). Those which constitute the cementing material, (i.e., the pure bitumen), and which determine the value of the asphalt, are termed hydrocarbons, and these different hydrocarbons, when burned, yield varying amounts of coke or fixed carbon. The amount of fixed carbon produced by burning the asphalt will, therefore, vary in accordance with the kind and proportion of the different hydrocarbons present in the asphalt. For this reason the determination of the amount of fixed carbon in connection with other tests is of use in the laboratory in determining the source or origin of an asphalt.

If we knew just what hydrocarbons or combination of hydrocarbons were best suited for paving purposes the most we could do would be to determine theoretically what the fixed carbon content of an ideal paving asphalt should be. As a matter of fact, the identification of all these various hydrocarbons is not possible in the present state of our chemical knowledge and even if this difficulty were removed, we know from past experience that certain hydrocarbons which by themselves are worthless for paving purposes form, when combined with other hydrocarbons, some of our best paving asphalts. For instance, a paraffine flux which is low in fixed carbon would be useless by itself as a paving material and yet when combined with one or more suitable hard asphalts forms an asphalt cement such as has been successfully used in laying millions of square yards of asphalt pavement. Even with the good and bad hydrocarbons all identified, the question of their various combinations would make it mathematically impossible to theoretically predetermine useful limits for the fixed carbon contents of suitable refined asphalts or asphalt cements for paving work, as we would find both good and bad asphalts included in these limits.

In a large majority of cases asphalt cements are made by fluxing hard asphalts with a suitable flux. It frequently happens that refined hard asphalts which show over 15% of fixed carbon will, when fluxed into an asphalt cement of proper consistency and quality for use, show less than 15% of fixed carbon. Is the ban to be placed on them also or are they to be considered as coming within the approved class? It would certainly appear to the writer as being more logical to apply the fixed carbon test to the asphalt cement than to the refined asphalt. If the requirement is to apply to the refined asphalt alone, what is to prevent the manufacturer from fluxing the hard asphalt to a point where it shows less than 15% of fixed carbon and where its consistency is but slightly be-

low that required for paving work and designating the fluxed material as a refined asphalt? If all the theoretical and practical objections previously noted are to be disregarded, it is at least evident from the foregoing that if any limit is to be set as to the fixed carbon contents of an asphalt or asphalt cement the only proper and just data for determining such a limit is that which has been obtained from pavements laid with the various asphalts then and now in use. In this connection the following table, showing the amounts of fixed carbon found in the more commonly used paving asphalts and fluxes, will be of value:—

Bermudez	12 to 14 %
California	9.5 to 18 %
Cuban (Mariel)	13 to 14 %
Gilsonite	15 to 25 %
Grahamite	40 to 55 %
Mexican	15 to 19 %
Texas	13 to 16 %
Trinidad	10 to 13 %
Paraffine fluxes	2.5 to 4.0%
Semi-asphaltic fluxes	5.0 to 7.0%
Asphaltic fluxes	6.0 to 9.5%

Taking the asphalts which show less than a maximum of 15% of fixed carbon, we find that these include Bermudez, Cuban (Mariel), and Trinidad. The service record of all of these asphalts is sufficiently good to place them in the accepted class.

We next have the class in which the minimum fixed carbon falls below 15% and the maximum above 15%. These include California, Gilsonite, Grahamite, Mexican and Texas. The writer has had a very long and intimate acquaintance with the manufacture of California asphalts and the laying of pavements with them since the very earliest days of the industry. It is true that in the early days some California asphalt was produced showing 18% and even higher of fixed carbon. It must be remembered, however, that several grades are and were manufactured, some of them for paint and varnish purposes and these latter were much harder and necessarily higher in fixed carbon than the grades manufactured for paving purposes. In a number of cases when stocks ran low, as they frequently did in those days, the hard asphalt was shipped and used for paving work. The writer, moreover, has laid a number of pavements with just such asphalts and where they had not been cracked to such an extent as to destroy their solubility in fluxes and their cementing value, the pavements laid with them gave just as good results as those laid with asphalts lower in fixed carbon. In many cases the high percentage of fixed carbon contained in those California asphalts manufactured for varnish and paint purposes have been misleadingly quoted against California paving asphalts in general as showing their unfitness for paving purposes and the lack of care used in manufacturing them. It is history, however, that these very same carelessly manufactured asphalts, often showing high fixed carbon, proved so great a commercial success in the paving industry that the interests controlling the so-called natural asphalts attempted to control them in one vast organization. Since about 1895 gradually increasing amounts of pavements have been laid in the United States and elsewhere with California asphalt until at the present time there are many millions of square yards of pavements of this character in existence which are giving good service. There is no doubt but that a considerable proportion of the California asphalt manufactured between the years 1895 and 1900 showed over 15% of fixed carbon, but the writer is in a position to state positively that, having in mind the state of the art at that time, the average of these pavements gave just as good satisfaction as the average of the pavements laid during the same period with other asphalt showing less than 15% of fixed carbon.

Mexican asphalts normally run higher in fixed carbon than do most others. Pavements laid with this type of asphalt have been in use in Mexico, Canada and the United States for upwards of five years. A careful physical and chemical examination of them proves that they possess all of the qualities which are necessary and essential for laying a first-class asphalt pavement. They are almost 100% pure bitumen, are higher in ductility and cementing value than any others excepting the California, and are less susceptible to changes in temperature than any other paving asphalt of recognized quality. From the above data and the fact that they are produced by the same approved and time-tested methods and with the same care used in manufacturing the best California asphalts, which have proven so successful, the writer is convinced that there is every reason for including them in the list of paving asphalts of the highest quality.

Many thousand square yards of successful asphalt pavements have been laid with asphalt cement manufactured from Gilsonite. It is a fair statement to make that if the present price of Gilsonite were not so high, it would be much more widely used at the present time in the paving industry. Most of the Gilsonite available for paving purposes will show considerably in excess of 15% of fixed carbon. When fluxed with California residuum, the asphalt cement so produced will in most instances show less than 15% of fixed carbon. The service tests of pavements laid with asphalt cements of this character are undoubtedly sufficiently good to include them in the preferred class of paving asphalts. The use in the paving industry of asphalt cements made from Grahamite, which is very high in fixed carbon, has been limited, but a number of excellent pavements have been laid with this material.

Much of the so-called Texas asphalt as present upon the market will show less than 15% of fixed carbon. Occasional shipments of it, however, will run up to 16% or slightly over. Chemical and physical examination of the shipments showing over 15% of fixed carbon, together with the service records of pavements laid with them show that the high fixed carbon material is just as good as the low fixed carbon material. In fact, it is impossible to detect any difference between them. It would appear to be clear from the foregoing that, based on service tests alone, there is no reason for inserting a fixed carbon clause, or, if inserted, limiting it to a maximum of 15%. Such a maximum would limit the asphalts admitted to Bermudez, California, Cuban, Texas and Trinidad. Practically all of the present-day output of California asphalt would be admitted, together with a large proportion of the so-called Texas asphalt. Gilsonite, Grahamite and Mexican asphalts would be excluded. At the present time but small quantities of the first two asphalts are used in the paving industry, but the volume of Mexican asphalt produced in this country is very large and increasing very rapidly. From a commercial standpoint, its competition with Bermudez and Trinidad asphalts is more serious than that of any other asphalt. At the present time it is admitted under all of the standard open specifications now in force in the United States in most of the largest cities, so that it is reasonable to assume it to be of good quality. From the municipal standpoint, it is

exceedingly important that free and open competition in standard asphalts should be encouraged and maintained. From this point of view, it would be unfortunate indeed to bar out what is admittedly one of the most important factors in the asphalt situation to-day. The Mexican oil fields are concededly one of the largest, if not the largest, which have ever been developed and their supply is practically inexhaustible.

The old and artificial brand standard of judging quality is rapidly disappearing and in an attempt to preserve it in a manner which can not readily be detected, a large number of tests are being advocated under the plea that they are necessary ones. As a matter of fact, most of these tests are purely identification tests and are intended to limit the asphalts admitted under them to certain brands. It is well that municipal engineers should understand this matter thoroughly and be warned against it and only accept tests in their specifications which have been proven to be quality tests and essential in determining the actual paving value of an asphalt. It would appear, therefore, that the chief effect of a 15% fixed carbon clause would be to exclude Mexican asphalts. The authors of most of the articles which have appeared in your pages agree that asphalts produced from Mexican oils should normally show a high fixed carbon content. The strongest advocates of the fixed carbon test agree that its chief influence is to prevent an undue amount of condensation or cracking from taking place. In all asphalts produced, either by nature or man, a certain degree of condensation has taken place. It is only where this condensation is excessive that any objection can be raised to it. Asphalt manufactured from Mexican oil with all the care and precaution that years of experience has proved to be necessary will normally show over 15% of fixed carbon. From this standpoint, therefore, its exclusion is unjustifiable. From the laboratory standpoint its physical and chemical characteristics show it to possess in the highest degree the properties which have been found to be desirable and necessary in a paving asphalt. As to service tests, since 1911 over thirty thousand tons have been sold for sheet asphalt paving purposes in Canada and over sixty thousand tons in the United States. Disregarding entirely the favorable results of these service tests and the fact that it is being freely used in open competition with all other asphalts by most of our largest cities and in many municipal paving plants, it is unreasonable to assume that any such quantity of it could have been sold if it were an inferior asphalt. Contractors would have refused to bid upon it and assume maintenance guarantees. The strong inference is, therefore, that the opposition to its use is purely a commercial one.

One of the arguments which have been used in favor of the fixed carbon test is that while it may bar out certain good asphalts, it safeguards a municipality by insuring the use of only such asphalts as are suitable for paving purposes. From the standpoint of the fixed carbon test only this is not true. A great many blown asphalts which are not recognized as being suitable for paving purposes show less than 15% of fixed carbon. In fact, it is probably fair to state that taking 15% of fixed carbon as the dividing line, there are more poor asphalts showing less than 15% of fixed carbon than there are poor asphalts showing more than 15% of fixed carbon. It is apparent, therefore, that the fixed carbon test *per se* is not sufficient to insure a good paving asphalt, but that this can only be done in connection with other tests. If these other tests are sufficient to exclude the large number of poor asphalts showing less than 15% of fixed carbon, it is certainly logical to assume that these same tests will be sufficient to exclude poor asphalts showing more than 15% of fixed carbon. From this standpoint alone there would appear to be no reason why a fixed carbon test of any kind should be included in a specification for paving asphalt.

Certain points have been raised in the articles which have been published in your pages which appear to the writer to call for further comment. In discussing Mr. Pullar's paper,* the writer wishes it to be distinctly understood that as a whole his experience confirms most of the facts stated by Mr. Pullar, but that he is not in accord with the conclusions drawn by him from these facts.

Mr. Pullar, in his article, states that the ductility test in the hands of different chemists gives more widely varying results than does the fixed carbon test. The writer and his partner have probably had a greater experience with this test than anyone else and he thinks it only fair to state that when the standard method is followed the variations stated by Mr. Pullar are far too great. Assuming, however, for the sake of argument, that the ductility of the same sample was reported by two different chemists as 90 cms. and 70 cms., respectively, both of these results are so far above the usual minimum requirements for ductility that the sample would be unhesitatingly accepted as passing the requirements in this respect.

As a matter of fact, the variation in different results on the ductility test is no greater than on the fixed carbon test and all the widely known and used standard paving asphalts have a ductility far in excess of the usual minimum limit given by specifications (20 cms.), so that the allowable variation would not work a hardship on any of them or cause them to be excluded. This is shown by the following table giving the average range of ductility for cements of 50 penetration made from the asphalts mentioned in the previous table of fixed carbon contents:

Bermudez	40 to 70 cms.
California	90 cms. and over
Cuban (Mariel)	20 to 30 cms.
Gilsonite	20 to 50 cms.
Grahamite	15 to 30 cms.
Mexican	50 to 100 cms. and over
Texas	50 to 100 cms. and over
Trinidad	35 to 60 cms.

The writer has gone into the matter of the ductility test at the present time more especially because this test is employed in almost all specifications and amply guards against all undue blowing of asphaltic products.

In this connection Mr. Pullar quotes tests on a number of blown products made from Ohio and other oils. In the first place, blown products of this class are not generally considered as suitable for paving purposes and certainly not when made from Ohio oil *per se*. Products of this character would not be admitted under any of the standard paving specifications. The instances cited would, therefore, appear to have little or no bearing upon the value of the fixed carbon test for paving specifications. As a matter of fact, it is easier and cheaper to produce a blown asphalt from Mexican oils which will show less than 15% of fixed carbon than it is to produce from them a paving asphalt of good quality and high ductility that will normally contain from 15 to 17% of

*"The Value of the Fixed Carbon Test," *The Canadian Engineer*, November 13th, 1913.

fixed carbon. If the ductility test in the usual open type of specifications were eliminated and the fixed carbon test substituted, any manufacturer could cheaply and easily make an inferior product from Mexican or other oils that would meet the specifications. This could, of course, be prevented by introducing a number of additional tests, but why cumber the specifications in this way and make them still more difficult for the average engineer and contractor to understand when a ductility test answers every purpose?

Mr. Pullar further states that a poor quality of fluxing oil will show up by high fixed carbon in a fluxed asphalt. This statement requires very considerable modification. For many purposes fluxes made from asphaltic oils are superior to those made from paraffine oils and yet the former are higher in fixed carbon. A relatively high fixed carbon in a fluxed asphalt would, therefore, in many instances indicate a better product than a low fixed carbon. Where the fluxed bitumen was a very hard one and was only partly soluble in a paraffine flux and wholly soluble in an asphaltic flux, Mr. Pullar's statement would, of course, be entirely correct, but when the hard asphalt was equally soluble in both kinds of fluxes and relatively the same amount was used in each case, the product made with the asphaltic flux would show the higher fixed carbon.

The writer strongly disagrees with Mr. Pullar that the majority of so-called open specifications are so faulty as to permit the use of undesirable material. It is his experience that under them better asphalts are being supplied than for years past and that the practice of dividing bituminous material into various classes is a cumbersome, confusing and useless one. His views on this particular subject are quite fully set forth in a previous issue of your paper; page 175, Jan. 15th, 1914.

Much has been written against the so-called "cracking" of an oil during the manufacturing process and that this necessarily injures the paving value of the asphalt and that this also is shown by the fixed carbon test. The writer is of the opinion that so long as the essential physical qualities of the product are not injured, cracking *per se* is not necessarily injurious. This may appear to be a somewhat revolutionary doctrine, but in many instances he and others have successfully used cracked products so long as their stability and cementing value had not been injuriously lowered, and in the early days of the paving industry practically all the fluxes were cracked products and they often formed 25% of the asphalt cement used.

Coal tar has long been successfully used in the paving industry and it certainly is a much cracked product, notwithstanding which it will retain its original consistency longer than asphalt and is certainly equal to it in cementing value, even though it frequently shows 30% or more of *fixed carbon*.

Mr. Kirschbraun's article* is an exceedingly able and interesting one. The writer believes, however, that his formula (based on the crude used) for determining the allowable amount of fixed carbon in an asphalt does not sufficiently take into consideration the variation in fixed carbon contents produced by different methods of distillation. This is indicated by the California asphalt mentioned by Mr. Pullar as containing only 9.5% of fixed carbon against the normal range of 11 to 14% in asphalts made from the same class of crude. His table on page 803 of your journal illustrates that a California "B" grade asphalt showing 16.3% of fixed carbon may be converted into a bright ductile cement showing only 12.6% of fixed carbon by the use of a suitable flux. This accords with the writer's experience. No other tests are given on the cement by Mr. Kirschbraun, but the writer has made similar cements which were in every way suitable for paving use and has employed them in laying pavements which were in every way successful and permanent. This shows that when combined with a suitable flux, asphalts which have been cracked in distillation and have a high fixed carbon test, are not necessarily injurious or unfit for paving *providing they have the other necessary qualities of stability and cementitiousness.* Where one type of crude is being used and the same process of distillation is employed, the fixed carbon test will undoubtedly check up variations in the handling of the stills and it is concededly valuable for that purpose, as is also the carbon tetrachloride test. At times one of these tests will show variations which the other will not. Mr. Kirschbraun states: "It is apparent that the best practice should limit this action (condensation) to the minimum and that specifications should control this by a fixed carbon limit within which the product will retain to a useful and permanent extent the qualities necessary for pavement and road construction." Possibly the writer misunderstands Mr. Kirschbraun, but he fails to see how this could be done practically. First, we have the variation due to different crudes; second, the variation due to different approved methods of refining upon the same crudes; third, the influence of various fluxes on the asphalt cement; and fourth, the determination in each particular case of the amount and kind of condensation which is harmful. If the allowable percentage of fixed carbon is to be regulated in accordance with the qualities necessary for road or pavement construction, why not specify the permissible limits in these respects and omit the at least doubtful and variable fixed carbon requirement? The ductility test will always detect lack of cementitiousness due to improper manipulation or any other cause. Hence it accomplishes all that has been claimed for the fixed carbon test without any unfair discrimination.

Mr. Kirschbraun, in his letter appearing in your issue of January 29th, proposes that the minimum theoretical fixed carbon value characteristic of an asphalt of a given penetration made under ideal refining conditions should be determined by a laboratory run, the idea being to establish a fixed carbon standard for products made from a particular crude. Laboratory methods differ as much as do producing methods on a large scale and for this reason alone the proposition seems to the writer to be impractical. It also involves the assumption that any degree of condensation in the commercial product in excess of that produced by the laboratory method employed is harmful. This argument, if carried to the extreme, would involve the use of distillation processes conducted under less than atmospheric pressures, which the writer believes to be in most cases entirely unnecessary. In his own experience asphalt produced in this way has at times been found inferior to that produced in a commercial manner with a very considerable degree of condensation, in that the product made under diminished pressure was susceptible to changes in temperature to an undesirable extent.

Mr. Kirschbraun suggests an alternative clause in which he places a maximum of 13% of fixed carbon and a sliding scale whereby any increase in the fixed carbon contents shall be compensated for by an increase in the solubility of the material in carbon tetrachloride. This appears to the writer to be an attempt to use what he

* "Fixed Carbon Depends on Crude." *The Canadian Engineer*, December 4th, 1913.

considers tests of very questionable value to counterbalance each other.

Reverting again to the California asphalt mentioned by Mr. Pullar as containing only 9.5% of fixed carbon and assuming this to be a paving asphalt of high grade, why should any other California asphalt made from the same crude be permitted to have as much as even 13% of fixed carbon? Here, again, the question of the refining processes used becomes a very important matter in determining the allowable amount of fixed carbon, and no matter what limits as to fixed carbon and carbon tetrachloride solubility are determined upon, it becomes necessary to revert to other tests to safeguard the material to such an extent that the value of the fixed carbon test itself appears negligible.

Mr. Kirschbraun also suggests that if the chemist has no faith in the carbon tetrachloride test, this solvent might be replaced by carbon disulphide. The writer fails to see how this latter solvent could be of any value unless the material had been so far decomposed as to coke it. The products made from paraffine base oils are admittedly entirely unsuitable for paving purposes and yet these are the lowest in fixed carbon. Products made from asphaltic crudes of any sort are always higher in fixed carbon than those made from paraffine crudes. On this ground alone, therefore, it would appear to be more logical to limit the minimum amount of fixed carbon permissible in an asphalt than the maximum amount. In any event, other tests are required to determine the fitness of an asphalt, and, as previously stated, if these other tests are sufficient to discriminate between the good and bad materials having less than 15% of fixed carbon, it would appear that these same tests were also sufficient to discriminate between the good and bad materials having over 15% of fixed carbon. Why, therefore, use the fixed carbon test at all? From the standpoint of the inspecting chemist, the fixed carbon test undoubtedly has a certain value, but to introduce it properly into a specification so as not to discriminate against certain materials and yet have the provision of any use appears to the writer to be impracticable. He believes that a clause inserted in the ordinary open type specifications to the effect that all shipments of material shall be fully equal to the established standard and recognized quality of that particular brand will prove to be all that is necessary provided that the requirements as to cementing value or ductility, purity, susceptibility to changes in temperature and stability under heat are sufficiently high.

The writer agrees with Mr. Kirschbraun that the fact that the fixed carbon test was originally devised for the examination of coal does not necessarily mean that it is of no value in the examination of other materials, such as asphalts. He does not believe, however, that the authors of some of the articles which have appeared in your pages have objected to the fixed carbon test as applied to asphalts solely on the grounds of its origin. It appears to him that in view of the fact that the fixed carbon test as applied to coals is of value in judging them from the fuel standpoint, unless good and sufficient reasons are advanced to show that this test when applied to asphalts conclusively determines something entirely different, i.e., their suitability for paving purposes, it is wholly pertinent and logical to show that a test which has only been proven to measure fuel value has no place in an asphalt specification.

Mr. Law's paper* clearly shows the variations in results obtained by different chemists with the fixed carbon test and points out the cause for many of them. He also points out the absurdity of rejecting a material for being a few tenths of a per cent. in excess of specification requirements when the limit of accuracy of the method employed is less than the excess upon which the rejection is based.

*"Fixed Carbon Test Empirical."—*The Canadian Engineer*, November 20th, 1913.

Mr. Richardson's letter* ignores details entirely and proceeds upon the broad, and (to him) satisfying, assumption that all asphalts showing more than 15% of fixed carbon are inferior or experimental. This, the writer contends, is wholly unjustifiable and is not borne out by the experience gained during the past 15 years in the paving industry. It can not, therefore, be considered a very valuable contribution to the present discussion. Millions of square yards of pavements made with "residual pitches," as he terms them, have been and are being laid by his own company and others, and the results have proved that they are fully equal to pavements laid with the so-called natural asphalts which he advocates. Gilsonite has also been used in the laying of many successful pavements and much of this material shows over 15% of fixed carbon. So far as stability is concerned, all of the good asphalts made from asphaltic petroleum are more stable under heat than one of the asphalts which he advocates so strongly.

FRANCIS P. SMITH.

New York, January 31st, 1914.

*"Fixed Carbon Limitation."—*The Canadian Engineer*, December 18th, 1913.

MINERAL PRODUCTION OF ALBERTA FOR 1913.

As Alberta is the province with the greatest coal resources in all Canada, so it is developing rapidly as a producer of coal, the output for the year being estimated at about 3,500,000 tons, or nearly half the production of Nova Scotia, the oldest and largest coal-producing province. During the year thirty new coal mines were opened. The International Coal and Coke Company was the largest producer of both coal and coke, and distributed $30,000 a quarter in dividends, being equivalent to 1 per cent. per quarter. The Canadian Coal Consolidated Company, of Frank, was practically closed down this year, the production amounting to 13,958 tons. The Hillcrest Collieries at Hillcrest produced over 300,000 tons. The city of Lethbridge runs the Lethbridge City Mine, which produced about 21,750 tons. The Diamond Coal Company closed down their mine on June 1st, up to which time the mine had produced 17,503 tons. The mines in the North and through the Yellowhead Pass experienced a quiet year.

The production for the year is estimated as follows:—

Coal, 3,500,000 tons	$ 8,750,000
Coke, 100,000 tons	660,000
Cement and building materials	2,500,000
Natural gas	1,875,000
Total	$13,775,000

Venice, Italy, has appropriated $20,000 to investigate the advisability of building a highway tunnel of 11,800 feet between that city and the islands of Giudecca, San Giorgio and Lida. If this investigating body reports that the plan is practicable, such construction will mean the passing of the picturesque gondola system of transportation. If the project is carried out the tunnel will be the longest highway tunnel in the world.

PROGRESS ON THE MOUNT ROYAL TUNNEL.

DURING the recent Annual Meeting in Montreal of the Canadian Society of Civil Engineers, the Mount Royal Tunnel and Terminal Company fittingly recognized the large assembly of Canadian engineers in (1) an invitation to visit and proceed through the tunnel—an opportunity which was largely taken advantage of by the members; and (2) the circulation of a 50-page booklet descriptive of the project and the methods adopted for the carrying of it to a speedy and successful conclusion. This pamphlet contains in concise form a great deal of value in the way of information on the subject of tunneling, and we strongly feel like recommending our readers interested in the same to write Mr. S. P. Brown, Chief Engineer, Mount Royal Tunnel and Terminal Co., Montreal, for copies for themselves.

The major portion of the reading matter, and many of the illustrations have been published in past issues of *The Canadian Engineer*, but the notes on the progress of excavation work, extracted below, have not previously appeared. Before beginning this, however, our readers are referred to the following articles for more complete information respecting the planning and carrying out of this project:—

Fig. 1.—General View at the West Portal, Showing Plant and Tunnel Entrance as Seen at Present.

(1) A general description of the scheme, giving proposed location of tunnel and terminals; description of compressor plant, shops, and adopted methods of excavation, was published in *The Canadian Engineer* for January 16th, 1913.

(2) Additional data and numerous photographs, describing in detail the mechanical arrangement of plant and outlining the lines upon which drilling operations were conducted, was contained in *The Canadian Engineer* for February 6th, 1913.

(3) An article on the precise survey and measurement work, prelminary to the commencement of actual boring, by Mr. J. L. Busfield, assistant engineer, Department of Surveys and Alignment, appeared in *The Canadian Engineer* for February 27th, 1913.

(4) In our June 12, 1913, issue, announcement was made of the record in drilling which had been established during the month of May.

(5) July 10th, 1913, issue contained a description of the cross-section which had been adopted for the tunnel, and the factors attending the choice.

(6) The system of electrification decided upon was described in *The Canadian Engineer* for October 9th, 1913.

(7) A description of the electric locomotives to be used, together with equipment for control and operation, appeared in our issue of December 4th, 1913.

(8) An article by Mr. Busfield, on the underground survey work which was responsible for such a successful meeting of the headings, was published in *The Canadian Engineer* for January 22nd, 1914.

Geological Conditions of the Tunnel.—According to publication referred to above, Mount Royal, about 700 feet high, is the result of a volcanic intrusion of igneous rock forced upward through the original bed of Trenton limestone. Whether it was ever an active volcano is doubtful, as there is little evidence of lava, although it may have been scoured away by glacial, or other action, at the same time that the higher portions of the mountain were similarly eroded. There have evidently been several stages of eruption or intrusion, as both the limestone and main igneous body of so-called Essexite are broken and cut by a multitude of dikes and sheets of quite different character and evidently later origin. The trenton limestone, at a considerable depth, is found to be hard and crystalline, and is an excellent rock for tunneling. This rock, when in close proximity to a large igneous body, is sometimes highly impregnated with epidote, quartz, garnet, and other minerals.

At the city end, going west from Dorchester Street, the heading for the first 2,000 feet is in a soft black limestone, somewhat blocky and in places partially disintegrated, with occasional stretches of earth roof. The earth, above the limestone, consists of sandy clay, boulder clay, occasional layers of hard pan, fine sand and large bodies of blue leda clay. This being under the city proper, forms the most difficult ground and conditions to be encountered, and a roof shield will be used.

As the rock cover increases the rock becomes harder and more dikes of extremely hard igneous rock are encountered. By the time 3,000 feet of heading had been driven, from Dorchester Street, the heading (except for the dikes) was in good, sound Trenton limestone, becoming more crystalline. It was in this that the record progress was made.

The greatest difficulty encountered in drilling and excavating is due to the irregularity of the structure. Some of the limestone is so impregnated with various contact minerals that it is extremely hard to drill and some breccia is so broken and uneven that in places one hole would be lost out of three started. The worst trouble, however, occurred when large dykes were encountered which necessitated entirely changing the temper of the steel used; for instance, in the heading going east from the West Portal a dyke of porphyritic Camptonite, an extremely hard rock, four feet thick, continued in the face for 400 feet. Here two tempers of steel were required in the heading all the time. This greatly retarded the progress and materially increased the cost of excavation.

Another very difficult rock is a marmorized limestone that was found in one of the headings. This marble is impregnated with quartz and a natural cementing material that makes it hard to drill and causes the muck to set up so rapidly that it is very difficult to shovel into the cars.

In general, the Trenton limestone is an excellent tunneling rock although the roof is sometimes inclined to scale badly and where this ground is cut by dykes the tunnel walls are apt to be insecure. When this limestone

is badly distorted by neighboring igneous intrusions it is apt to be filled with internal strains which cause it to crack and fall making it rather treacherous and requiring heavy timbering and masonry lining.

Often, especially in the limestone, cavities are found filled with calcite crystals of both the dogtooth and nail-head pattern. Here, too, is found a good deal of saponite and pyrites in various forms. Considerable Dawsonite, Feldspar, metallic arsenic and gypsum have been found from time to time, but not in quantities to be commercially valuable.

Heading Excavation.—Time being of vital importance in the Mount Royal Tunnel, it was decided to adopt a bottom centre heading which could be driven ahead rapidly, without much regard for the character of the ground, and from which the full-sized excavation could be developed at as many places simultaneously as desired. The headings are driven 8 to 10 feet high by 12 to 14 feet wide (over 50% larger than the headings of the principal Alpine tunnels) for the sake of ultimate economy. While this somewhat reduces the rate of progress, it very much decreases the cost of further excavation and construction; permitting reasonably broad-gauge double track through the break-ups, where the full size tunnel section, 22 feet high by 30 feet wide, is developed.

In the headings three principal methods have been used. In the method where the rock was not so hard as to require an excessively heavy drilling equipment, the drills are mounted on a horizontal bar and the equipment is handled in and out of the heading by hand. During this stage at the city end the heading cross-section was reduced to about 8 by 12 feet for the sake of rapidity in progress. Here no drill carriage was used, as much lighter drills were required, and a progress of 810 feet was made in the 31 working days following May 1st. This is the greatest linear progress ever made in a hard rock heading on this continent and has only been exceeded in Switzerland.

Four drills are used in each heading, supported on a horizontal bar. These drills are operated by compressed air at about 100 lbs. pressure per square inch. Each drill is fitted with special connection so that water may be forced through the piston and drill steel, which are hollow, into the bottom of the hole being drilled, thus keeping it cool and clean.

It is also interesting because both the linear feet of drilling (about 650 feet per 24 hours) and cubic yards of excavation (93 cubic yards per day) exceed anything ever accomplished in the European tunnels.

As the headings got into the hard igneous rock heavier drills were required, so that the total drilling equipment, including drills, saddles, arms and bar, weighed several tons. To carry this mass two types of drill carriages were devised. Each carries the drill bar on a long cantilever arm having a reach of over 20 feet beyond the carriage and is so arranged that the drills never have to be dismounted from the bar nor disconnected from the hose-manifold which is fastened to this cantilever arm. Thus the only connections to be made, when moving out or setting up, are the main air and water hose to the pipe lines entering the heading, and the only labor is that of jacking the horizontal drill-bar tightly into position after it has been brought in and placed by the drill carriage.

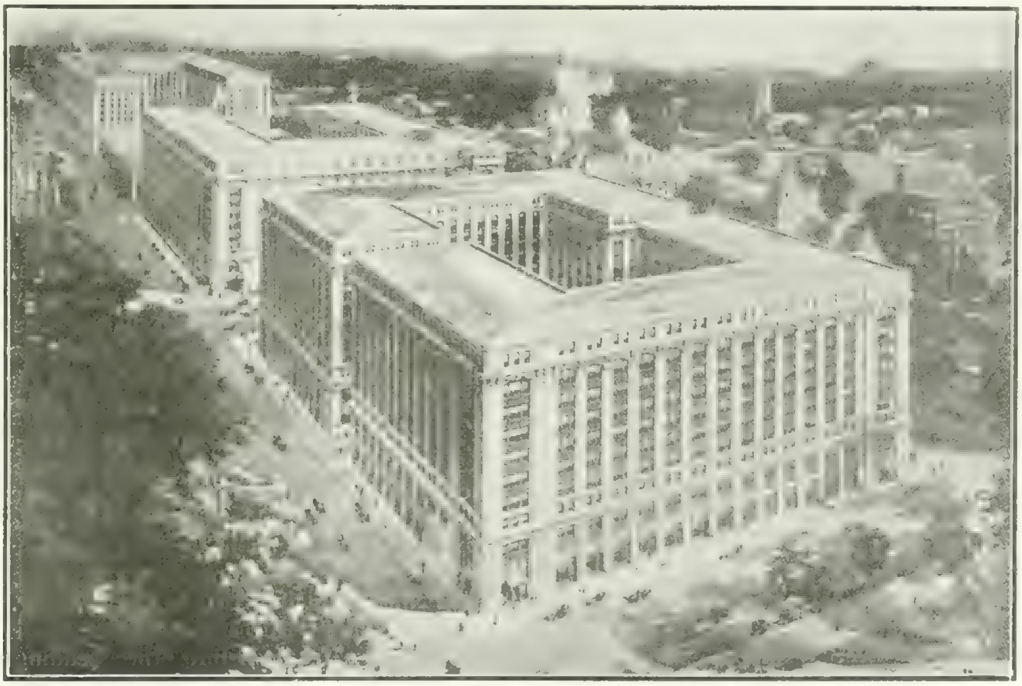

Fig. 2.—Proposed Buildings for the C.N.R. Passenger Terminal, Montreal.

All drill carriage track is riveted to steel plates so that the track may be cleared rapidly to within about 25 feet of the face after each shot, merely throwing the muck right and left. In the case of the muck-handling drill carriage the track is laid on one side of the heading while the other has its track down the centre. These machines save wear and tear on both men and machines, and make a surprising difference in the efficiency of both. With these machines the drills are in the heading ready to be jacked into place by the time the drillers have the loose rock barred down from the sides and roof and the muck thrown back sufficiently from the face to enable the bar to be set. Thus the time spent in setting up and taking down is much reduced. It is also notable that less muckers are required with this system than before the drill carriages were installed.

One drill carriage is so designed that the cantilever arm is given its motion, longitudinally, transversely and vertically by motor-driven attachments. This machine remains in the heading after the drills are placed and has a belt conveyer running through it longitudinally about 18 inches above the track, which elevates and dumps the muck into cars in the rear. This was used in one of the headings, as shown in Fig. 3.

The effect of installing the muck-handling drill carriage is shown to a remarkable degree by the difference in progress obtained without any increase in force. For the six months prior to its installation the average progress in this heading was 350 feet per month. For the six months after the installation of the drill carriage the average progress has been 485 feet per month. This is an increase of 38%. Furthermore, it must be remembered that before the drill carriage was installed the heading was in limestone, for the greater part, while the drill carriage has been working almost exclusively in Essexite. The best month, May, 1913, was 510 feet in 27 working days. This heading is 10 feet high by 12.5 feet wide.

The average yardage removed from this heading, including the 4 break-ups now working, is about 500 cubic yards, place measurement, per day. The linear progress in these break-ups is about twice that of the heading.

The other drill carriage used has no motor attachment and is removed from the heading after the drills are placed, leaving the cantilever arm attached to the drill bar and supported on a gallows frame which leaves the heading open for mucking, as shown in Fig. 4. In this case the cantilever arm is advanced by the locomotive which pushes the drill carriage into the heading. The lateral and vertical movement are obtained by jacks and by hand. The progress with this carriage is almost identical with that of the other.

The average progress over the entire job since the headings were started in the tunnel has been 420 feet per month in each heading. This makes no allowance for delays or lost time. It must also be remembered that for six months on the city end the blasting was restricted between the hours of 11 p.m. and 7 a.m. to avoid public annoyance. The average progress, where blasting has been unrestricted, has been 430 feet per month in each heading. From the time the first heading was started in the tunnel until the final meeting almost exactly fifteen months have elapsed, giving a gross progress of 1,100 feet per month.

The general heading procedure is as follows:—

After a round of blasts has been completed the loose rock is barred down from the roof and sides and the muck (i.e., the broken rock) is thrown back from the face sufficiently to permit the horizontal bar and drills to be set up. These are erected, connected with the air and water lines and drilling commenced. From 18 to 24 holes, 5 to 8 feet deep, are drilled in the heading. In the meantime the muckers have cleared the tracks, and are shovelling the muck into the cars, or onto the conveying belt where the muck-handling drill carriage is used. Smooth steel plates, called slick sheets, are laid in the bottom of the heading before each blast, for the muck to fall on, so that the muckers shovel off a smooth surface.

Where no drill carriage was used three muckers threw the muck back from the face to the slick sheets and four shovelled it into the cars. These four men, on each shift of 8 hours, handled all the muck made in that shift. Thus, during the record month, each man handled from 12 to 15 cubic yards of muck per shift, which, considering that about two hours of each shift were lost in blasting, was a most unusual performance.

All blasts are fired electrically from the lighting circuit; the blasting switch and leads being carried on the opposite side of the heading from other electric wires. Where time fuses are not used the rounds are usually fired in four shots; 1st, the cut holes, which form the opening wedge; 2nd, the relieving holes, immediately surrounding the cut; 3rd, the line holes, which break the heading to its full width; 4th, the dry holes, which break the heading to its full height. Sometimes the line holes and dry holes are fired together when the ground is breaking well.

When time fuses are used the cut is fired in the usual way with ordinary exploders so that if, as is very often the case, the cut does not break to the bottom at the first shot it can be fired a second time.

After the cut has been fired the rest of the heading is loaded with time fuses, cut at two-inch intervals, running in length from two inches up. Two of each length of fuse are used around the cut, the shortest fuses being closest to the cut and the longest being the two bottom corner holes so that the muck will be thrown back from the face by the last explosion. These fuses are ignited by electric igniters exactly similar in construction and resistance to the regular electric exploders. Thus all fuses are ignited simultaneously and regular exploders may be discharged at the same time if desired. This method saves time in blasting and leaves the men much fresher than if they had to go back into the smoke again and again. As all the fuses are very short the danger from cut-off holes is practically eliminated; in fact there has been no trouble from this source whatever thus far. This method is also used in all the break-ups.

In the heading a round of shots is fired from 3 to 6 times a day (24 hours). During the record month, with three exceptions, six shots were fired every day.

Break-up Excavation.—The break-ups (see Fig. 5), where the upper part of the tunnel section is excavated to its full width and height, are opened at intervals of 500 to 800 feet along the centre bottom heading. As many of these may be opened as are necessary to keep up with the heading progress, the advance in each break-up being about half that in the heading.

In making the break-up excavation heavy jumbo timbers are framed into the heading, about two feet apart and planked over, so that as the rock is blasted down from above, it can be run through the jumbo timbers into the muck cars in the heading beneath.

The break-ups are advanced by carrying an entry, about 15 feet ahead of the wing wall excavation, the same width of the heading and to the full height of the roof. A horizontal bar is used with 4 drills as in the heading. Immediately after shooting the bar is set up above the muck and the upper half of the entry is drilled. Then the bar is removed to the other end of break-up, and while the upper half of that entry is being drilled the muck is removed from the first entry. Thus when the upper half of the second entry is drilled the bar may be set up again in the first entry and the lower half drilled. By the time this drilling is finished the muck is removed from the second entry and the lower half of that may be drilled. In the meantime two columns with a single drill on each are set up in the wings and these drilled so that all the drilling is finished at the same time.

In the limestone two drilling shifts will break all the ground that three mucking shifts can handle economically. As the blasting is always breaking to two faces the drilling is comparatively light and very little powder

is required; the powder actually amounting to less than one-quarter that required in heading work. The blasting in the break-ups is done with time fuses which are ignited electrically. Thus it will be seen that the break-up excavation requires but little labor and explosive, being both rapid and economical. With four break-ups and one heading working at the back of the mountain the average excavation was about 500 cubic yards of place measurement daily, all of which goes out through the west heading to the main crusher plant.

A very important advantage of this method of tunnel driving is that where bad ground is encountered no material delay is experienced. The bottom heading progresses on through the bad material, which is treated carefully at leisure later on. This saves much time in the ultimate completing, and much money and risk in the construction. Some bad ground in break-ups where heavy internal stresses developed in the roof, require considerable timbering. This will be all concreted in with a reinforced single arch before the steam shovel reaches it, so that neither time nor money will have been lost.

In connection with the physical risk involved by this method it is interesting to note that within 15 months since the tunnel headings were started and with nearly a mile and a half of break-ups completed there has been only one fatal tunnel accident.

Bench Excavation.—The side benches, below the level of the jumbo timbers, are taken out, after the break-up excavation has been completed, by a steam shovel operated by compressed air. By this method the benches may be drilled and blasted well in advance and by a special loading device the usual delay in spotting cars is avoided, and no time will be lost by the shovel, making this excavation very cheap and rapid.

At places where a steam shovel cannot be used because of timbering, special construction, or shield work, the benches will be handled by hand and a belt conveyer loading into the tunnel cars.

Shield Work.—At the city end where very soft heavy ground is encountered under most unfavorable conditions, a steel roof shield has been adopted. This avoids settlement of overlying material, reduces the drainage of the surrounding ground, and eliminates the very heavy and expensive timberwork that would otherwise be necessary.

This shield consists of a cutting edge, shaped to conform to the outline of the tunnel roof cross-section, which forms the front of a steel envelope extending over the platforms on which the men work and back far enough to lap over the last "ring" or section of tunnel lining erected. Steel poling boards, semi-attached to the shield will be used, especially in the boulder clay, thus producing a cutting edge that may be advanced in sections where desired.

The shield is supported on steel columns forming the centre wall and on side walls which rest on the solid rock. It is forced ahead by hydraulic jacks, under a pressure of about 5,000 pds. per sq. in. These jacks push against the tunnel lining as it is erected.

The procedure is as follows:—

After a shove, i.e., a move of the shield, 27 in. ahead, a ring of concrete blocks, 27 in. wide, along the axis of the tunnel, by 24 in. thick and about 5 ft. long circumferentially, are set up in place by means of a hydraulic erector. When this tier of blocks is in place, the jacks are put in motion, jamming the new blocks hard against the last tier erected and forcing the shield slowly ahead, as fast as the ground is excavated in front of it. The excavated material, like that in the break-ups, is dropped directly into cars in the heading below. As soon as this shield has made a shove of 27 in. the process is repeated.

Where boulders are encountered the shield will be retarded and the steel poling boards advanced along the rest of the shield face for the 27-in. shove, when the boulder will have been removed in part or wholly.

Where special rectangular sections are built, a steel structure will be erected and steel sheeting used over and around it. This steel sheeting will be advanced by jacks, the structural steel and enclosing concrete being placed under the sheeting as it advances.

By this method the roof is never exposed; the men are never endangered by falling material, and if water is encountered the face can be protected by poling and breast boards with small pneumatic guns, or jacks, so that very little water or ground can escape.

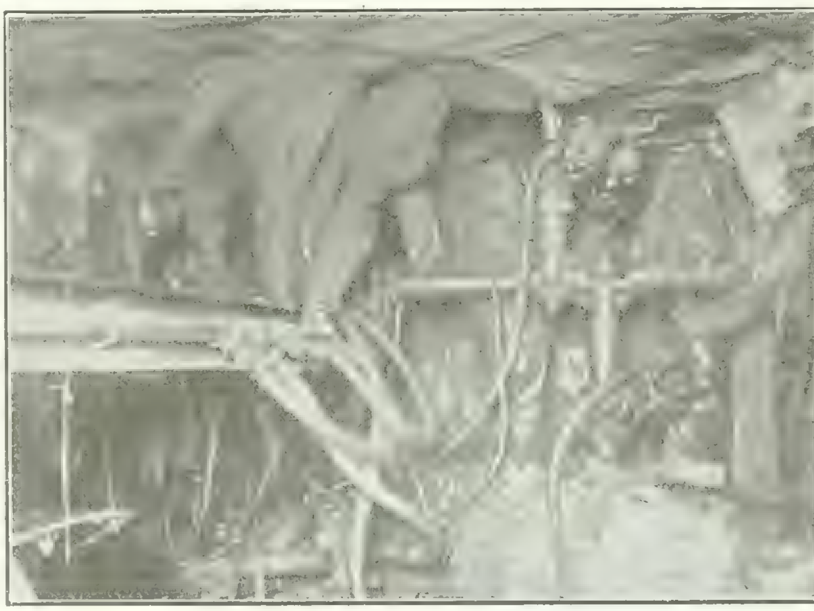

Fig. 3.—Heading Excavation Using Muck Handling Drill Carriage.

The blocks used are very massive and so designed that each block locks firmly into the two adjoining ones of the preceding ring, by oval shaped tenons. They are thus self-supporting and require no forms such as are usually necessary for concrete work. Since they are moulded many weeks in advance, before being brought into the tunnel, when they are erected under the shield they are sufficiently hard to withstand the thrusts of the jacks without injury. The blocks are also so designed that the extrados of the arch is continuous. but the joints in the intrados are about 1¼ inches wide. These joints are held to shape primarily by 3 part wedges or separators and later filled with mortar by means of a cement gun and grouting.

Crusher Plant.—All the rock excavated in the tunnel is being crushed for road materal and concrete stone. All that is not used by the company or railway is sold for local consumption about Montreal. The main crusher plant at the west portal consists of two No. 7 Kennedy gyratory crushers with Stephens-Adamson elevators, con-

veyers and screens. The capacity is about 1,600 cubic yards per day. The tunnel muck is hoisted in cars up an incline to tipples. After dumping, the empties are returned to the tunnel level, through a gravity switchboard. The muck passes through the crushers and is elevated to a revolving screen which separates the stone into the various sizes and distributes it by chutes into bins. It can then be run directly into trucks or cars on tracks connected with both the C.P.R. and G.T.R. The overflow is carried on belt conveyers to various stock piles for the different sizes of stone. From these piles the stone is loaded by means of a locomotive crane and clamshell bucket.

At the city end the tunnell rock is sold as it comes from the tunnel and crushed by an outside company.

The following synopsis gives in a few words the main features of the tunnel itself:—

Length, 3 1/10 miles.

Heading in station site, ⅓ mile.

Grade, 0.6% down towards the city.

Section, 23.5 feet high by 31 feet wide, standard excavation.

Type, twin tube.

Depth, 600 feet below summit.

Geology, Trenton limestone and Essexite with igneous dykes.

Method, bottom centre heading and break-ups.

Progress, best single heading 810 feet in 31 working days, averaging 420 feet per month in each heading.

Gross average, 1,100 feet per month.

An estimate of quantities of material is as follows:—

Excavation, 20,000 cubic yards of earth; 405,000 cubic yards of rock.

Concrete, 50,000 cubic yards.

Steel and iron, 4,400,000 lbs.

Shafts, Maplewood, 240 feet deep; Dorchester, 55 feet deep.

Present pay roll, 1,000 employees.

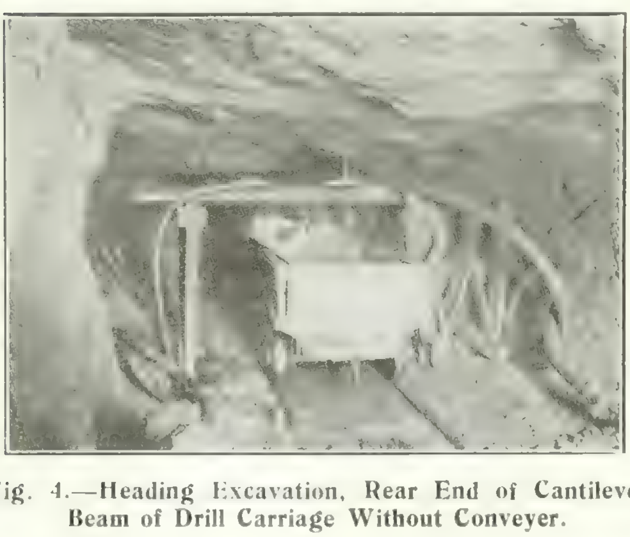

Fig. 4.—Heading Excavation, Rear End of Cantilever Beam of Drill Carriage Without Conveyer.

Present daily consumption of 60% dynamite, 2,000 pounds.

Present daily rate of solid excavation, 900 cubic yards.

Concerning the terminal site, exclusive of buildings, the figures given below are announced in the report:—

Length, 1,200 feet.

Width, 350 feet.

Depth, 50 feet maximum.

Total tracks, 13.

Excavation, 540,000 cubic yards earth; 95,000 cubic yards rock.

Concrete, 100,000 cubic yards retaining walls, track, slabs and platforms,

Reinforcing steel, 3,500,000 lbs.

Structural steel, 8,000,000 lbs.

The Mount Royal Heights station, as designed, gives the following estimate:—

Length, 500 feet.

Depth, 35 feet maximum.

Excavation, 24,000 cubic yards earth; 7,000 cubic yards rock; concrete, 7,000 cubic yards.

Fig. 5.—Break-up Excavation, Showing Bottom Heading With Jumbo Timbers.

Personnel.—The engineering and construction organization is under the direction of Mr. S. P. Brown, B.Sc., Managing Engineer for Mackenzie, Mann & Co., Limited, and Chief Engineer of the Mount Royal Tunnel and Terminal Company, Limited. In the Department of Design, Mr. W. C. Lancaster, E.E., M.E., is electrical and mechanical engineer; and Mr. H. D. Robinson, B.Sc., is engineer of structural design. The Department of Surveys and Alignment is in charge of Mr. Howell T. Fisher, Tunnel Engineer. Assisting him are Mr. J. L. Busfield, B.Sc., on the eastern division, and Mr. R. S. Bassett, B.Sc., on the western division. Mr. J. C. K. Stuart is first assistant engineer, Department of Construction, while Ed. Duffy and Richard Byers are superintendents of the eastern and western divisions respectively.

FINAL WORK ON GATUN DAM.

The two wings of Gatun Dam have been practically finished, the crests being raised three feet above final level, in order to allow for settlement. The remaining work on the dam proper will be in grading the top after the settling. Spoil from the borrow pit beyond the west end of the dam is now being placed at the west end of the east wing, next to the spillway, to cover the draft tubes leading to the hydroelectric station, and to connect the dam by suitable slopes with the side wall of the spillway discharge-channel. The total amount of material placed in the dam to December 1st, 1913, according to the Canal Record for December 24th, was 22,052,666 cubic yards.

Over 1,400 water meters were installed by the city of Regina during 1913.

AMENDMENT TO THE SASKATCHEWAN PUBLIC HEALTH ACT OF INTEREST TO MUNICIPAL AND CONSULTING ENGINEERS IN THE PROVINCE.

AN amendment was passed at the recent session of the Saskatchewan Legislative Assembly, which will prove of interest and advantage to municipalities in that province contemplating the establishment or extension of public health works, and to the engineers acting for such municipalities. The Public Health Act of Saskatchewan is frequently referred to as providing the most advanced legislation in the Dominion with regard to waterworks, sewerage and sewage disposal control.

Previous to the passing of the amendment referred to, the Act required that complete plans and specifications of all waterworks, sewerage or sewage disposal systems or extensions, should be submitted to the Commissioner of Public Health, and his certificate of approval obtained, before any by-law for the purpose of raising money for such works could be submitted to the votes of the electors; and further, that no debentures would be valid if issued under any by-law passed in contravention to the foregoing requirement.

The Commissioner has received the hearty cooperation of the various municipalities in the administration of the Act, but he has noted that in some cases, particularly in the smaller towns, the preparation and submission of complete plans and specifications, previous to the passing of the by-law was a matter which called for re-consideration, because of the following circumstances.

(1) A municipal council taking up office in January required some six weeks in which to formulate the constructional programme for the year. The engineer, on receiving his instructions, proceeded with the preparation of plans and specifications which occupied at least two months. These plans and specifications were submitted to the Commissioner of Public Health during the month of April, and assuming that they were satisfactory to the Commissioner, the by-law could not be voted upon until it had been advertised for three successive weeks. Thus, the electors did not vote until about June 1st, and the necessary procedure following the passing of the by-law, usually delayed the letting of the contracts until the constructional season was far advanced.

(2) Consulting engineers engaged by municipalities had of necessity to incur considerable expenditure in rushing the preparation of detailed plans and specifications, for which remuneration was not forthcoming in many cases until debentures were sold.

(3) There was a possibility of the by-law being opposed by a majority of the ratepayers, in which case, the preparation of the details of the scheme meant unnecessary expense to the municipality.

The difficulties raised will be met by the new amendment, wherein it is required that a report, general plans and such information as may be required to allow of a general understanding of the proposed system or extension may be submitted, and a provisional certificate issued by the Commissioner, which will be sufficient for the purposes of the by-law.

No debentures will, however, be valid until the complete plans and specifications of the system have been submitted and approved.

Regulations will shortly be issued from the Bureau of Health, stating definitely what form the various plans and data necessary for the provisional and final certificates shall take.

SEPARATING WATER FROM CREOSOTE OIL.

By Thomas White,
Assistant Manager of American Creosote Works.

IT is an established fact that it is practically impossible to obtain creosote oil entirely free of water owing to the origin of the oil. After the purchase of almost water-free oil it requires eternal vigilance to keep it so. Some methods of effecting a separation of the water were described by Mr. Thos. White, at the annual convention in New Orleans, of the American Wood Preservers' Association. From his paper the following is reproduced.

Among the conditions which bring about this intrusion of water are difficulties to be expected from the nature of the treating business. Among these are to be mentioned leaks in the steam coils of the storage and treating tanks and cylinders caused by the acids of the oil or the timber, steam condensation and moisture from the timber in the cylinders, or if the plant uses underground tanks seepage of ground water into these through open seams or pin holes. While some water from rainfall becomes mixed with the oil if in open tanks, this can be siphoned off directly from the top. This free water is really an asset in that it affords positive fire and lightning protection.

In these varous ways water is slowly accumulated in the oil. This water is readily gotten rid of by the use of the steam coils in the tanks which are brought into every-day use, but if kept cold in a reserve storage tank which is only drawn on at wide intervals we may expect some difficulty from it. In this cold condition the contents will stratify in the tank into three main horizontal zones, each of varying depth, depending upon the gravity of the oil. The top zone will be free water floating over the middle one, which is an emulsion, while the bottom zone will contain the least amount of water, which we incorrectly say is in chemical combination with the oil. The water in this bottom zone is usually such a small portion, within our lawful allowance, that it will hardly be troublesome This zone is the most accessible in the tank, and very likely will be first used. It is the water in the middle zone which is most difficult to eliminate. Heating the contents to boiling point in an open tank with steam coils will create an upward circulation, which will continue after the steam has been shut off and until the liquid thoroughly cools. Since the water is lighest it will rise to the top, where it can be readily drawn off. If the tank is provided with an agitator it will greatly facilitate the operation, causing quicker evaporation and stratification.

The other method of water extraction, which is the best but not always justifiable at the creosoting plant, is the still method. Ordinarily, the use of the still for this purpose at the treating plant is so seldom required, coupled with its comparatively higher cost of installation and maintenance, make it rather prohibitive there. Although the still may be used to refractionate the oil to make either a lighter or heavier one, at the same time the open tank, with its necessary steam coils, is always reserve storage capacity.

Of the two styles of stills, namely, the horizontal and the vertical, the latter is thought by the writer to

be the more preferable for water removal, although the horizontal still seems to be used almost universally throughout the United States for tar distillation. Even from the point of construction and maintenance the vertical one is most favorable in that it would not require a separately built smokestack and when burned out at the bottom could be replaced easily. It should induce better evaporation in that there would be a more direct and quicker circulation of the gases. While the heating surface appears less this may be increased by the use of vertical fire flues, which would also serve as smokestacks. There would also be less tendency to foam, which means that the operation could be rushed more with less danger of the oil boiling out of the still.

The open-tank method described above should evaporate at least 1 per cent. of water per day while the liquid is kept heated above 180° F., not to mention the free water which would separate and rise to the top. The still method would probably evaporate about 1 per cent. of water per hour. The still would require extra fuel and attention, whereas the open-tank coils would tax the main boiler and its fireman very little more.

Of course, there are numerous other methods of water extraction, such as the centrifugal and vacuum processes, some of which might be preferred in individual cases.

THE WORKING OF GYPSUM.

Mr. L. C. Snider has published some good information in Bulletin 11 of the Oklahoma Geological Survey, concerning the calcining of gypsum.

Its principal commercial value arises from the fact that at the moderate temperature of 130° C., three-fourths of its water of crystallization is expelled, yielding plaster of paris. Water begins to come off below 100° C., but very slowly up to 130°. At 163° C. more water is expelled, and if a temperature of 221° is not exceeded, the resulting plaster is still serviceable, but if calcined above that temperature, the plaster becomes increasingly slow to set with the addition of water. At 343° C. gypsum is completely dehydrated, and the "dead burned" plaster loses all hydraulic properties, becoming $CaSO_4$, or anhydrite.

In practice, two dissimilar methods are employed for calcining gypsum. The older method uses kettles holding up to 25 tons. The gypsum is first pulverized by passing successively through jaw crushers, gyratory crushers, and buhr mills, and is then charged slowly into the kettles, which are heated from outside and are provided with interior stirring devices. In about 1 hr. after filling, the mass reaches a temperature of 230° F. and begins to "boil" by raped expulsion of water. When it reaches 350° F., the plaster is discharged into a cooling pit, and is afterwards screened, the coarser grains being reground.

The more modern Cummer continuous process utilizes a rotary kiln through which furnace gases and hot air are drawn by fan. In this method, the gypsum is crushed only to nut size before being fed automatically and continuously into the kiln. It passes through the kiln in about 10 min. and is discharged at a temperature of nearly 500° F., which, however, is not sufficient to "dead burn" the gypsum, owing to the presence of moisture which is not fully expelled during the short stay in the kiln. The hot gypsum is then stored in brick bins, where the mass acquires a uniform temperature just sufficient to produce plaster paris of the right quality. The calcined lumps are then pulverized and sifted. The advantages of the latter method are (1) that less than half so much fuel is required per ton of output, owing to the continuity of the heating, and (2) less power is required to pulverize calcined than raw gypsum.

COAST TO COAST.

St. Mary's Ont.—A new C.P.R. station at St. Mary's has been opened recently for public use.

St. Thomas, Ont.—Water has been pumped into the new water tower at St. Thomas, and no fault has been found in the construction.

Edmonton, Alta.—Estimates amounting to $1,325,161 as expenditure for maintenance and operation of the city utilities department are being considered by the Edmonton City Council.

Port Nelson, Ont.—The last mail received from Port Nelson, which arrived at Ottawa, contained the information that the tower of the wireless station being constructed there to connect with Le Pas, had attained the height of 150 feet on December 15th. It is estimated that, by this time, it is complete.

Guelph, Ont.—The annual report of the road superintendent submitted last week at the county council showed the amount expended under the Highway Improvement Act last year to be $61,283.95. Of this sum, $25,968.97 was expended upon bridges, and $35,314.98, upon culverts and general road construction .

Ottawa, Ont.—The annual report of the N.T.R. Commission for the financial year ending March 31, 1913, showed the total expenditure for construction as $13,729,461; or, the total expenditure from March, 1904, to March, 1913, as $130,-247,152. The total grading done by March, 1913, was 1,739 miles. The total miles of track laid was 1,720 miles on the main line and 384 miles on sidings and double track, making a maximum total of 2,125 miles.

Winnipeg, Man.—The surplus on the operation of Government telephones for the year ending November 20, is shown by the report of the Hon. Hugh Armstrong, provincial treasurer, to be $30,264.64. The total revenue for the year is quoted as $1,707,149.74; net earnings, $437,239.84; and interest charges, $406,975.20. The report also details large expenditure on new construction during the year, as well as a general increase in the salaries of employees throughout the system.

Verdun, Que.—Some months ago, Verdun embarked upon a project to prevent just such an emergency as occurred recently in Montreal—i.e., it reorganized its water service, the result being that within a few weeks, it will have in operation a new pumping plant capable of supplying to the town 4,000,000 gallons daily, this in addition to two reserve pumps, which at present supply 3,000,000 gallons daily, making a total of 7,000,000 gallons; while the total consumption of the town at present is only 1,000,000. The new pump is supplied by a separate intake, the two already in existence supplying the two reserve pumps, and will provide, when it is completed, three distinct and complete sources of water supply. In addition, the water will be filtered.

Fort William, Ont.—A busy season in ship repair and construction is reported at the harbor of Fort William, and also at the Port Arthur drydocks. At Fort William, the tugs "Sarnia" and "Home Rule," owned by the Thunder Bay Contracting Company, are undergoing extensive alterations and repairs; and the eight dredges which have been working in the harbor during the past season for navigation, are being overhauled in preparation for next season's work. At Port Arthur, the work on the large steel freighter under construction is progressing favorably and it is expected that the vessel will be launched about the end of March. Also new motors have been installed in the C.P.R. steamers "Alberta" and "Athabasca"; new pistons are being installed in the engines; the wiring system of the boats is being entirely renewed; new anchors have replaced the old-fashioned ones; and alter-

ations to the cabins have been commenced. Repairs have also been completed to the "Plummer," "Dwyer" and the tug "James Whalen."

Regina, Sask.—Considerable interest is manifested in Regina in the natural gas proposition made by the Coste-McAuley Syndicate, which has been favored by the city council. According to the terms of this agreement, the city will secure natural gas at the rate of 20 cents per cubic foot, which will mean that power can be supplied to industrial concerns at a nominal figure without incurring any loss to the city. The power problem has been recognized by the city for some years past as a difficult one; and, although Regina's rates were lower than those of practically every city in the west, it was recognized that the advantage to industrial concerns was to a certain extent off-set by the high rate for power. With natural gas at this price, it is claimed that power rates for such as milling enterprises, etc., would be reduced to a minimum; and all of Regina's business men are very optimistic with regard to the probability of greater industrial development. The gas will be secured within 100 miles of Regina, and piped to the city.

Montreal, Que.—This city is now advertising for tenders for the fourth unit of work in connection with the filtration plant under construction. This last portion requires an approximate expenditure of $150,000, which will bring the total cost of the plant to about $1,350,000. The construction of the filtration plant was divided into four portions—namely, the supply and installation of the machinery; the construction of final filters, including gravel and sand beds; the construction of pre-filters and filtered water reservoir, and the construction of buildings. The first three contracts are not quite completed, much delay having been experienced in the laying of the foundations, which were damaged by frost in the course of last winter and had to be repaired. The British Electric Plant Company, of Alloa, Scotland, for the sum of $40,250, is supplying and installing the pumping machinery, which consists of 14 centrifugal pumps directly connected to the electric motors, 4 of which are of a capacity of 17,500 gallons per minute, 2 of 11,600, 2 of 5,800, 2 of 1,300, 2 of 330 and 2 of 150 gallons. The rotary blower to be connected to an electric motor has a capacity of 5,000 cubic feet of air against 5 pounds per square inch pressure. The contract also provides for the supply of 2 hand-operated cranes of a capacity of 6 tons. Mr. Norman M. McLeod is executing the contract for the second division of the work at a cost of $673,000, and also for the third division at a cost of $485,000. This third contract calls for 16 reinforced concrete pre-filters of the mechanical type of 3¼ million gallons each per 24 hours; and for a reservoir with a capacity of 6¼ million gallons.

Victoria, B.C.—Arrangements are being made for an early start this year on the water rights investigation work being carried on in Greater Vancouver and in the lower Fraser Valley. That portion of the work of particular interest to Greater Vancouver is the measurement of the flow in Lynn, Seymour, and Capilano Creeks and their tributaries; and calculations as to water storage possibilities on these streams and investigation into the watershed situation with a view to ascertaining what damage might be done to the water supply by the removal of the timber on alienated land. Much of this work has been under the direction of Surveyor W. C. Smith; and he will continue his field investigations during the coming season. The work in the entire district mentioned is under the control of E. A. Jamieson, one of the assistant engineers of the provincial water rights department. The work on the north shore will be under the immediate supervision of William Young, comptroller of the provincial water rights branch. The investigations of the water rights department will have the effect of putting Vancouver's claim in Seymour Creek on a more definite basis. It has been reckoned that there are 3,000 miners' inches of water in the creek, of which 1,700 are controlled by the city of Vancouver, including those acquired from Point Grey and Burnaby for conveying water to those municipalities. The volume of water has never been known with any certainty, and doubt has been expressed that there are 3,000 miners' inches in the dry season. Moreover, the surveys of the Seymour Creek watershed by the department of water rights will have direct bearing on the scheme for conserving the water supply being put forward by Vancouver. On the report of this department, and of the forestry branch which has been investigating the timber in the watershed, will depend whether or not the city will buy the timber rights and crown grants above Seymour Falls for a reservoir.

Vancouver, B.C.—It seems a certain thing that by early March the eastern portion of the new C.P.R. station at Vancouver will be occupied. When the office staff and regular facilities have been transferred to this new structure, the work of razing the old depot will be undertaken, and upon its site will be constructed the Granville viaduct, which is another of the terminal units planned by this railway system. The new station will measure across the tracks from east to west, 480 feet, or practically two blocks long. It is being constructed of red brick, terra cotta, and granite and limestone trimmings. Along the Cordova street side there will be ten great Corinthian free-standing columns and ten engaged columns, constructed of limestone. The great entrance will open out directly on Cordova Street. From this entrance straight through the general waiting-room will be the main entrance and exit to all trains. There also will be an entrance off Granville Street and one on the track side for third-class passengers from the wharves and trains. In all, there will be six entrances. There will be two floors below the street level on the track side. Baggage and express departments will occupy most of the room in these. Here also will be the mail room, telephone exchange, service department, pump and boiler-rooms, also two large electrical transformers for lighting the building and running the elevators. The lower mezzanine floor is to be occupied by the kitchen; the central portion of the main floor by the general waiting-room, which will be 150 ft. long and 60 ft. wide, with massive pillars at the sides and a ceiling heavily beamed and panelled, 40 feet above the floor. In this room the lunch counter will be installed. A large lobby will open from the main waiting-room for first and second-class passenger business, while the third-class waiting-room and ticket office will be on the upper mezzanine floor. On the main will be located also the general freight department, general passenger agents, baggage agents, claims agents, as well as the offices of the Canadian-Australian steamship service, commissary, etc. Finally, the attic floor will be occupied by the general staff and all offices, such as private bureaux, the draughting-room for the engineering department, the railway telegraph and the like.

PERSONAL.

CHAS. H. KEEFER, C.E., Ottawa, was elected to the Board of Directors of the American Society of Civil Engineers, at its annual meeting in January.

W. G. CHACE, Chief Engineer of the Greater Winnipeg Water District will address a meeting of the University of Manitoba Engineering Society, on February 9th.

S. G. PORTER, M.Am.Soc.C.E., addressed the Calgary branch of the Canadian Society of Civil Engineers at a meeting on January 23rd, on "The Engineer and his Relation to Society."

P. B. McGINNIS, until recently connected with the Canada Cement Company, in their Winnipeg office, has been

transferred to Medicine Hat to take charge of the construction work of the company's plant, No. 14, there.

A. N. PITCHER, who has been constructing engineer during the development period of the Canadian Coal and Coke Company in Alberta, has been appointed chief engineer. The head offices of the company are at present in Montreal, but they will be moved to the collieries near Lethbridge.

FRANCIS P. SMITH, M.Am.Soc.C.E., chemical and consulting paving engineer, New York City, on January 29th, delivered before the graduate students in Highway Engineering at Columbia University, an illustrated lecture on "Plant, Highway and Laboratory Inspection of Bituminous Materials."

GEO. JANIN, City Engineer of Montreal, has been seriously ill for several weeks and shows little improvement. The Board of Control has relieved him of all responsible duties for a month. During the repair of the conduit break a month ago, Mr. Janin remained continuously in charge, and his physicians now attribute his present illness to overexposure.

ARTHUR H. BLANCHARD, M.Am.Soc.C.E., Professor in Charge of the graduate course in Highway Engineering at Columbia University, on January 26, 1914, delivered illustrated lectures at the University of Illinois on the subjects:—"Bituminous Surfaces and Bituminous Pavements" and "Modern Developments in Highway Engineering in Europe."

DOUGLAS C. LIVINGSTON, B.Sc., a graduate in mining of McGill University, and for some years prominently connected with mining operations on Vancouver Island, has been appointed head of the mining engineering department of the University of Idaho. For the past three years he has been associate professor of mining. He succeeds Prof. R. S. McCaffery, who lately resigned to join the faculty of the University of Wisconsin.

H. N. RUTTAN, City Engineer of Winnipeg, addressed the University of Manitoba Engineering Society recently on "Advice to Young Engineers." Col. Ruttan dwelt first on the necessity for carefulness, accuracy and attention to detail, realizing from the first the sense of responsibility in all matters. He impressed the importance of loyalty, particularly to the chief of the staff. No engineering achievement is a one-man proposition, it requires the united efforts of the whole staff to bring it to a successful conclusion. The exercise of the faculties of observation to the fullest extent in connection with any project is necessary, and notes on all matters in relation to it are of great importance. The young engineer should not be content but should qualify for higher responsibilities. He must be well informed on all public matters of engineering interest, and be able to clearly present his views.

Recent appointments to positions in the Topographical Surveys Branch, Department of the Interior, Ottawa, include those of L. T. Venney, Brockville, Ont.; W. K. Thompson, Toronto; Alan Fraser, Toronto; L. S. Cockburn, Toronto; C. M. O'Neill, Erindale, Ont.; A. L. Morgan, Kingston; W. E. Lumb, Fort Stewart, Ont.; W. W. Doxsee, Peterborough, Ont.; H. J. Dunlap, Ottawa; and Jas. Hall, Edinburgh, Scotland. The first five mentioned are graduates in engineering of the University of Toronto.

OBITUARY.

THOS. M. McLEOD, C.E., of the firm of McLeod and Merrill, Toronto, and a graduate of McGill University, died recently of appendicitis. Mr. McLeod was a native of Georgetown, P.E.I. He had been connected with many extensive engineering contracts in Canada and the United States.

MANITOBA LAND SURVEYORS.

The thirty-fourth annual meeting of the Association of Manitoba Land Surveyors was held in the Industrial Bureau Buildings, Winnipeg, on January 21 and 22. After a very interesting address from the retiring president, J. L. Doupe, chief surveyor of the Canadian Pacific Railway Company, the following papers were read and discussed:—

"Early Surveys and Land Administration in Manitoba," by William Pearce, of Calgary.

"How to Treat the Closing Error," by C. C. Chataway, of Winnipeg.

"Accuracy in Field Work," by A. C. Garner, chief surveyor of the land titles office, Regina.

"Special Surveys," by G. B. McColl, of Winnipeg.

"Right of Way Surveys," by F. A. Wilkin, Winnipeg, right-of-way surveyor for the Canadian Pacific Railway Company.

"Street Plans and their Control," by H. F. McDonald, of Winnipeg.

"Some Useful Diagrams in Computing Earthworks," by H. L. Vercoe, Winnipeg.

The following officers were elected for 1914:—C. C. Chataway, president; R. J. Jephson, vice-president; W. B. Young, secretary-treasurer; and G. A. Bayne, H. F. McDonald, R. C. McPhillips and R. H. Avent, as members of the executive council; and H. G. Beresford and H. A. Bayne, as auditors.

"THE ELECTRIFICATION OF STEAM RAILWAYS."

This was the subject of an illustrated address by Mr. N. W. Storer, of the Westinghouse Electric and Manufacturing Company, Pittsburg, delivered to the Toronto section of the American Institute of Electrical Engineers on January 30th.

LECTURE ON STEEL TUBE MANUFACTURE.

The University of Toronto Engineering Society will hold a special meeting in Convocation Hall this evening (February 5th), at 8 p.m., which will be addressed by Mr. F. N. Speller, B.A.Sc., a graduate in engineering of the University of Toronto. Mr. Speller is Metallurgical Engineer for the National Tube Company, Pittsburg, Pa., and will give a lecture on the manufacture of steel pipes and tubes. His talk will be illustrated by motion pictures showing the methods of manufacture. The Canadian Railway and Engineering Club will attend the meeting in a body.

COMING MEETINGS.

WESTERN ONTARIO CLAY PRODUCTS ASSOCIATION.—Convention to be held in Chatham, Ont., February 4 and 5, 1914.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th, 1914. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

AMERICAN WATER WORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

WATER POWERS ON THE WINNIPEG RIVER

FROM A REPORT TO HIS HONOR, JUDGE H. A. ROBSON, PUBLIC UTILITIES COMMISSION, WINNIPEG, PREPARED BY THE WATER POWER BRANCH, DEPARTMENT OF THE INTERIOR; J. B. CHALLIES, B.A Sc., SUPERINTENDENT. J. T. JOHNSTON, HYDRAULIC ENGINEER

IT has long been recognized that there is an enormous reserve of potential water power on the Winnipeg River within the province of Manitoba. The rapidity with which the existing developments on the river have been, and are being increased to their capacity, and the active interest that has been taken in the undeveloped power sites of the river, have compelled the Dominion Government to give the water power resources on this river careful and full consideration. Within the last few years there have been presented to the Dominion Government many applications for power privileges on this river; schemes have been proposed for the utilization of various portions of the natural fall, some contemplating the combination of several falls by the concentration of their respective drops at one power site, and others simply proposing the utilization of the drop at a particular fall. These have been so varied and so conflicting, and at the same time supported by such reputable engineering advice, that the government found it inadvisable to commit itself with respect to any further developments on the river until it had first caused to be made a complete survey and investigation of the whole river, with a view to securing such information as would enable the dictation of developments which would con-

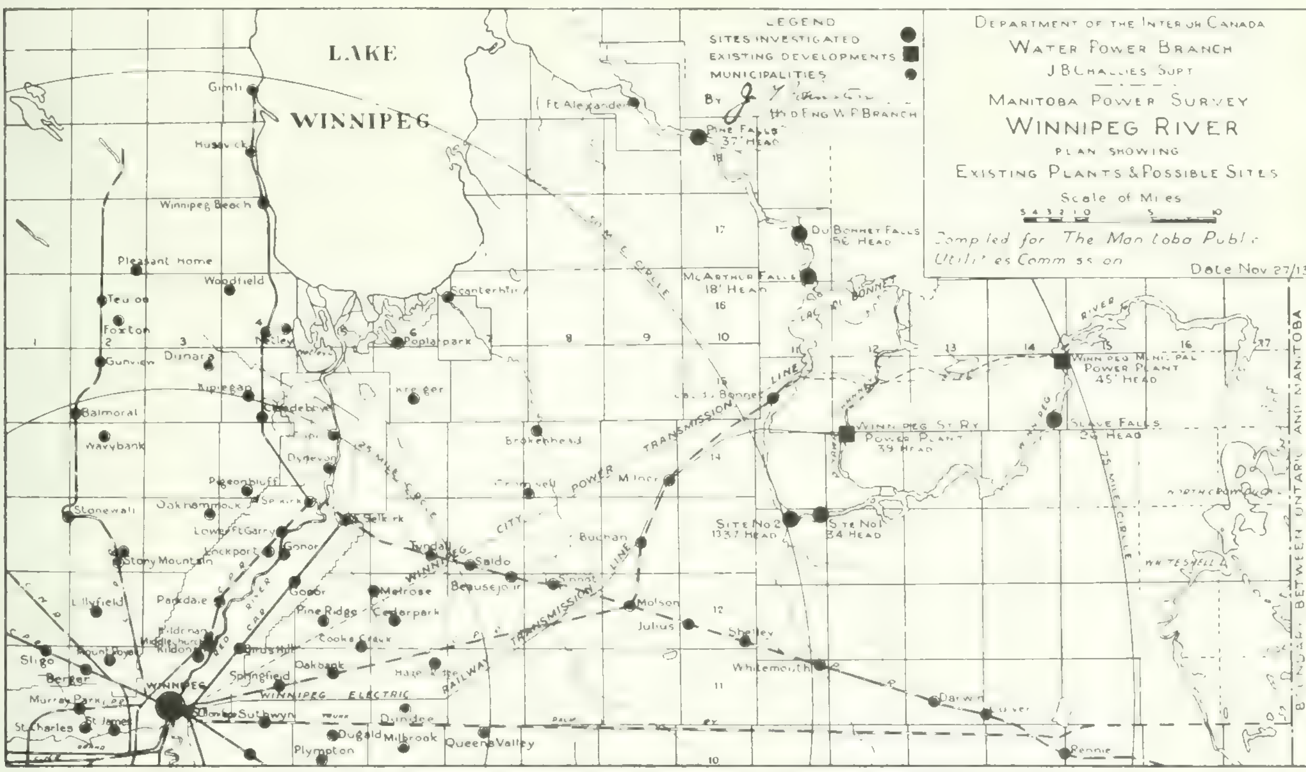


Fig. 1.—Existing Plants and Possible Sights Around Winnipeg.

template the maximum possible advantageous utilization of the water power resources of the river. These investigations were started early in the year 1911, under the consulting advice of Mr. J. B. McRae, C.E., of Ottawa, and the field work has proceeded vigorously to completion under charge of Mr. D. L. McLean. For the purpose of this report for the Public Utilities Commission, which had to be completed by December 15th, 1913, plans based on this field work have been rushed to completion, and a preliminary provisional estimate made by the engineers of the Water Power Branch, of the best method of concentrating the various separate falls of the river to enable all the natural fall to be utilized for power purposes, and at the same time have each unit develop-

ment a component part of the comprehensive scheme for the whole river. These concentrations are indicated in plan and profile on Figs. 1 and 2. A study of this profile will illustrate the completeness with which the objects on the continent; it flows in a westerly direction connecting the Lake of the Woods with Lake Winnipeg. The basin drained comprises an immense area of some 55,000 sq. mi., lying at the westerly end of the Lauren-

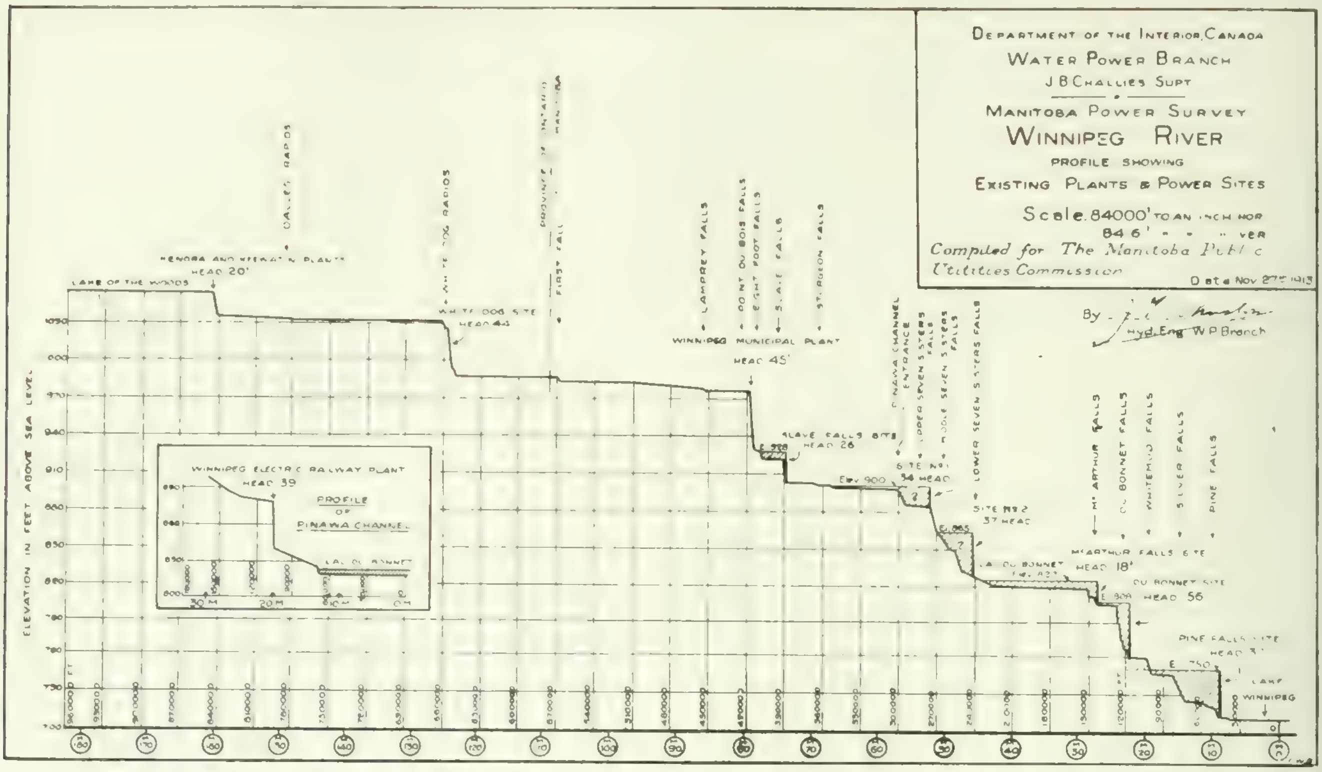


Fig. 2.—Profile, Winnipeg River Survey, Showing Existing Developments and Power Sites.

of the investigation have been realized, and the full conservation of the power resources of the river provided for.

Description of River and Drainage Basin.—The Winnipeg River is one of the most notable power rivers tian Plateau. As is typical of Laurentian country, the area is dotted with innumerable muskegs and lakes, the latter varying in size from small ponds to the Lake of the Woods with its area of 1,500 sq. mi. Certain gen-

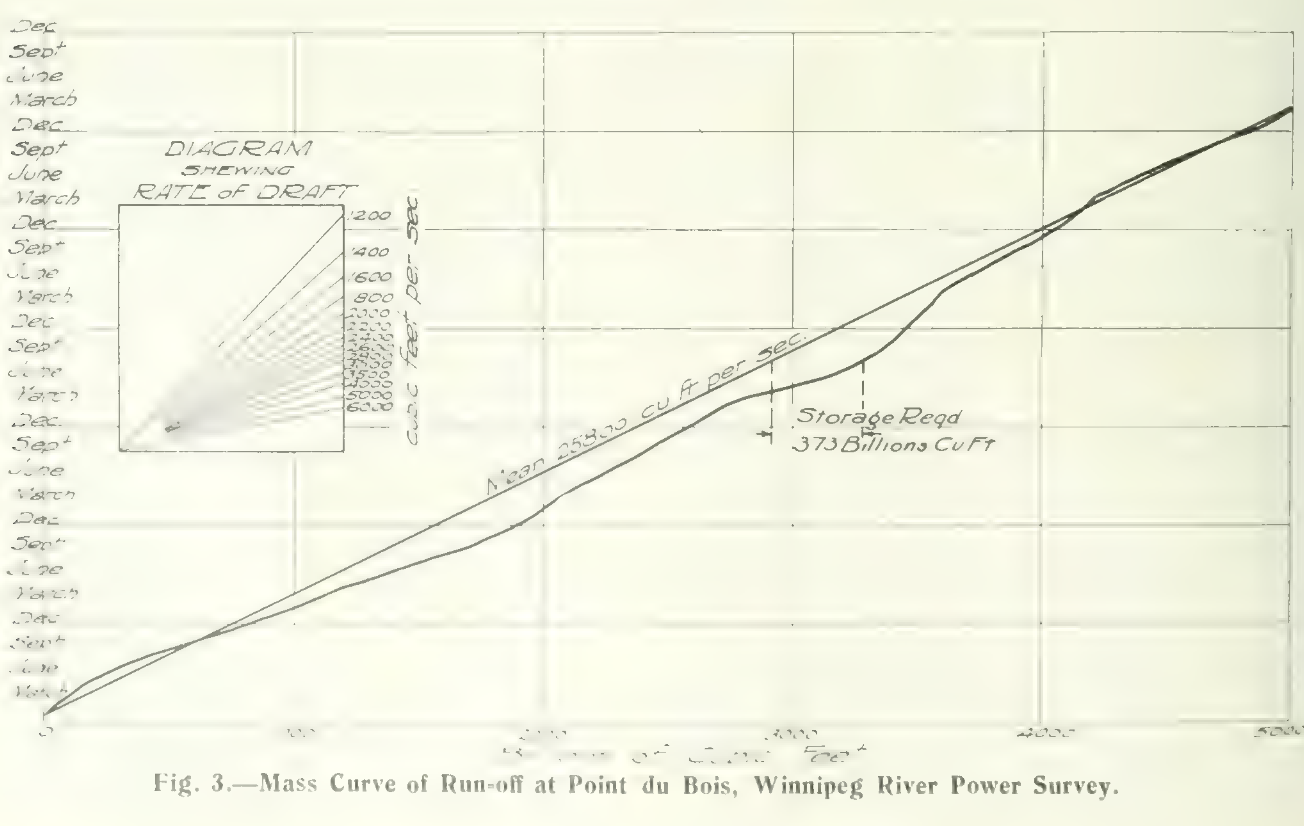


Fig. 3.—Mass Curve of Run-off at Point du Bois, Winnipeg River Power Survey.

eral characteristics apply to the drainage basin as a whole, since practically the entire area is of Laurentian formation with an overlying soil of glacial origin. The country is rough and hilly with large areas of rock outcrop. This latter feature applies in the main throughout the Winnipeg River, and lends itself to a characteristic formation throughout the river channel, which is of exceptional value in the interests of power development. The larger proportion of the river bed in the province of Manitoba, consists of a series of deep cup-like basins, forming small lake-like expanses with little or no current. The river flow finds its way from these basins by falls and rapids over the rock formation which is always in evidence at the outlets, and which forms at once the means of egress from, and the controlling feature of, the basin water level. These falls form the natural power sites along the river.

and finally discharging into Rainy Lake. These upper waters in the main constitute a portion of the International Boundary. Many streams heading in upper lakes and muskegs also contribute to the flow from Rainy Lake. This latter has a surface of 330 sq. mi., and a drainage area of some 14,600 sq. mi. Rainy River, which is the outlet, discharges into the Lake of the Woods. From this latter lake to Lake Winnipeg, the river is known as the Winnipeg. Forty miles down the river from the Lake of the Woods, the flow of the English River enters that of the Winnipeg. This tributary is of almost as large dimensions as the river into which it flows, as it drains an area of 22,000 sq. mi., while the Winnipeg at the Lake of the Woods outlets, has a drainage area of 25,000 sq. mi. From the Lake of the Woods to Lake Winnipeg, there is a total drop of 341 ft., and of this a 70-ft. drop takes place above and a 271-ft. drop

TABLE OF DEVELOPED & UNDEVELOPED POWER ON THE WINNIPEG RIVER.

Plant or Site	Head Water Elevation	Tail Water Elevation	Head	Turbine Capacity at Full Gate at Gov. Proposals: 12000 Sec. Ft.	20000 Sec. Ft.	H.P. @ 75% Eff. on a 24 Hr. Basis: 2000 Sec. Ft.	20000 Sec. Ft.	H.P. Developed	Capital Cost per H.P. on Switchboard: 12000 Sec. Ft.	20000 Sec. Ft.	Remarks
Winnipeg Municipal Plant	975.7	930.7	45	—	—	46100	76800	20800	—	—	
Slave Falls Site	928	902	26	40000	65000	26600	44400	—	$93.45	$83.30	
Winnipeg Electric Railway Co. Plant	879.4	840.4	39	—	—	—	—	26500	—	—	
1st Site Seven Sisters	—	—	34	—	—	11600	34800	—	—	—	
2nd Site Seven Sisters	—	—	37	—	—	12600	37900	—	—	—	
McArthur Site	827	809	18	27500	42500	8400	30700	—	123.00	97.50	
		762	46	70000	120000	47100	78100	—	79.40	68.90	
Du Bonnet Site	808	752	56	—	140000	57300	95500	—	—	70.70	
Pine Site	750	713	37	55000	96000	37900	63100	—	80.30	70.70	

TOTAL POWER WITH UNREGULATED RIVER (12000 SEC FT MIN FLOW) — 237000 H.P.

TOTAL POWER WITH REGULATED RIVER (20,000 SEC FT. REG FLOW) — 409.700 H.P.

TOTAL POWER DEVELOPED TO DATE .... 47.300 H.P.

Ottawa Ont. Dec. 12 1913

Fig. 4.

A valuable timber growth including spruce, tamarack, birch and pine, occurs throughout the whole district. Lumbering is carried on extensively, and in addition, pulp and paper industries have been established at Fort Frances and Dryden. Notwithstanding the great extent of rock outcrop, considerable area is available for farming, this applying more especially to the Whitemouth and Rainy River districts. While there are several prosperous towns such as Fort Frances, Rainy River and Kenora in the basin, yet the greater portion of the country has not been settled and is still in the state of nature.

The upper watershed reaches to the height of land separating the Atlantic drainage from that of Hudson Bay into which the waters of the Winnipeg River eventually flow. North Lake, which is situated on the International Boundary, some 45 miles west of Lake Superior, is the headwater of the drainage basin. From North Lake the stream flows westward, passing through many small lakes, collecting the flow of numerous tributaries

below the junction with the English River. As this junction occurs practically at the boundary between Ontario and Manitoba, it follows that the combined flow of the two rivers and the greater drop as noted above are available for power purposes in Manitoba. Of this head a considerable portion is already being utilized by existing developments on the river.

Flow Records.—Estimates of the daily flow of the Winnipeg River have been compiled by the Manitoba Hydrographic Survey, based on discharge measurements secured by them, together with results of measurements supplied by Col. Ruttan, D. A. Ross, and the City of Winnipeg power engineers. These estimated discharges are referred to the flow of the river at Point du Bois and extend over a period of six years. For this period a maximum flow of 53,400 sec.-ft. and a minimum flow of 11,700 sec.-ft. have been recorded. The high-water marks along the shore would indicate that floods of 100,000 sec.-ft. have occurred in the past. Such floods must, however, take place at rare intervals.

Storage on the Upper Waters.—The question of storage on the upper waters of the Winnipeg River is at present somewhat involved, in that the regulation of the Lake of the Woods has become an international question and is now before the International Joint Commission. Considering that the lake has a tributary drainage area of 25,000 sq. mi., and a surface area of 1,500 sq. mi., offering unexcelled storage facilities, it is of vital importance to the powers of the Winnipeg River, that storage should be had on this lake. Partial regulation of the drainage tributary to Rainy Lake is now controlled on Rainy Lake by the dam of the Ontario and Minnesota Power Company at Fort Frances.

Second of the Seven Sisters Falls Sites, Winnipeg River.

By the establishment of storage reservoirs on the English River, the flow of the latter can be regulated; and in conjunction with storage on the Lake of the Woods drainage basin, practically a complete regulation of the flow of the Winnipeg River in Manitoba can be attained.

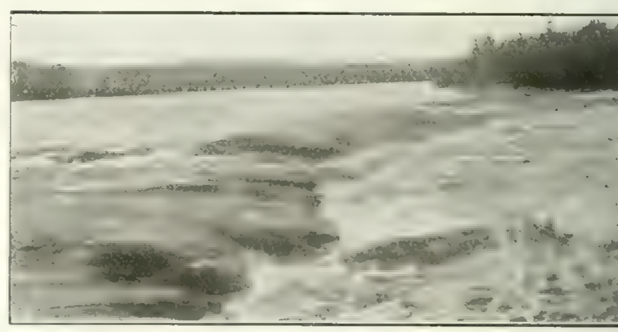
During the period of the last six years, over which records of the flow of the Winnipeg River extend, a minimum flow of 11,700 sec.-ft. has been recorded, as stated above, while the maximum flow in the same period is 53,400 sec.-ft., a range of only 1 to 4, which is illustrative of the extremely low fluctuation under practically natural conditions. Yet, by an adequate system of storage this flow can be so regulated that the minimum flow will be increased from about 12,000 sec.-ft. to some 20,000 sec.-ft. In Fig. 3 is shown a mass curve of the flow of the river at Point du Bois for the period from January 23rd, 1906, to December 31st, 1912. For this period a storage of 373 billion cu. ft. would have been necessary for a complete regulation.

Existing Power Plants.—(a) Winnipeg Electric Railway Co.—The Winnipeg Electric Railway Company's development is situated some sixty miles from Winnipeg on the Pinawa or Lee Channel. This channel was not the main river bed, but was an old high-water channel, of some 25 miles length which has been improved and is being further enlarged. The water for the plant is turned into the Pinawa Channel by three diversion dams, the main of which consists of 1,332 ft. of concrete capped rock fill across the main channel, connected with the banks on either side by concrete spillways bringing the total length to 1,650 feet. Two small weirs of timber crib type span secondary channels. The water thus diverted flows down the improved canal to a central dam which is capable of shutting off the flow and returning a portion or all of it to the main river over the waste or diversion weir. From this point the water flows through the tortuous bed of the old high-water channel, the same having been deepened and partially strengthened by excavation. This waterway, while at present capable of carrying in summer some 10,000 sec.-ft., is only able in winter, on account of the ice, to deliver about two-thirds of this amount. Below the power house the tail-race has been improved by much dredging and excavation. The power house is situated at a bend in the river where a concrete dam with arched spillway creates a thirty-nine-foot head. These headworks are equipped with debris boom, ice-run, spillway, trash-ranks and head gates. The electrical units of this plant consist of five 1,000-kw. and four 2,000-kw. revolving field, 60-cycle, two 300-volt, 3-phase generators, together with two 125-kw., 125-volt d.c. exciters. The generators are capable of carrying a 50% overload, giving in all a total output of 19,500 kw. or 26,140 h.p. While 19,500 kw. are available at this plant for peak loads, an additional 9,000 can be obtained from an auxiliary steam turbine station at Winnipeg operated by the company. The electric energy is transmitted to the City of Winnipeg at 60,000 volts over a 65-mi. transmission line.

(b) City of Winnipeg Municipal Plant.—The muninipal power development of the City of Winnipeg is situated some 77 mi. northeast from Winnipeg at Point du Bois on the Winnipeg River. This plant consists essentially of a large concrete power station, with retaining walls and spillways, forming the forebay, the entrance to which is controlled by a stop-log sluiceway type of headgate. Two concrete weirs or spill dams control the elevation of the headwaters, and together with a rock-fill dam divert the water to the forebay for use at the power house.

This power concentration has created a head varying from 44 to 48 ft., with a pondage of 7 sq. mi. above the plant. This pondage is a great asset during periods of peak loads.

The development is designed for an ultimate installation of 16 units, each consisting of two-runner high specific speed turbines rated at 5,200 h.p. for 46-ft. head and a 3-phase 3,000-kw. generator. The first installation would give 48,000 kw., with turbines of a maximum capacity of 83,200 h.p. As each turbine unit requires 1,250 sec.-ft. under maximum output at a net head of 45 ft. and running at 164 r.p.m., the total water required would be 20,000 sec.-ft., plus the water for the two small extra units.



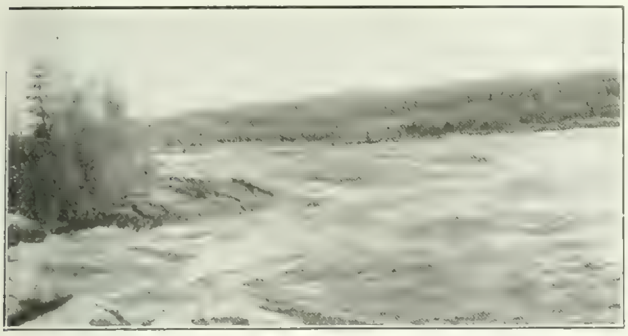
Main Drop of Second McArthur Falls, Winnipeg River.

The present installation consists of 5 generators of 3,000 kw. each and two exciters of 250 kw. each, making a total of 15,500 kw., and at maximum load requires 7,800 sec.-ft.

The electric energy is transmitted to the City of Winnipeg at 66,000 volts over a 77-mile transmission line, built on a municipally owned 100-ft. right-of way.

The conductors are of aluminum, supported on steel towers throughout. A duplicate line is now under consideration.

Basis of Discussion on Government Power Proposals.—The cost estimate for the government power proposals on the Winnipeg River refer in all cases to the capital cost of installation and are based on both an initial and final development. The initial development is designed to utilize at each site the present minimum flow of the river, i.e., 12,000 sec.-ft., or such portion of it as may be available at the particular site in question. The final development is designed to utilize at each site,



Main Drop of Pine Falls, Winnipeg River.

a regulated flow of 20,000 sec.-ft., or such portion of it as may be available at the site. After the diversion of sufficient water in the Pinawa Channel to operate the plant of the Winnipeg Electric Railway Company under normal peak load conditions, there would remain for use at Seven Sisters in the main river about 4,000 and 12,000 sec.-ft. under unregulated and regulated conditions of the river respectively. It is important to note that it is on this basis that the available power at the Seven Sisters sites is discussed.

In order that the power sites could be compared on a rational and equitable basis, all the layouts and designs have been standardized in so far as possible, giving full consideration to the varying heads, and to the local physical conditions at each individual site. No allowance has been made in the estimate for transmission, the costs being in all cases the capital cost for power on the switchboard in the power house, and the power being considered as straight 24-hour power at 75% efficiency, based on the flow. This forms a very conservative basis. Transmission costs are omitted from the estimates as it is impossible to foretell the use to which the power at the various sites may be applied when developed, and a straight comparison of the sites as they stand is desired. The costs given herewith may be slightly altered upon final revision.

In all cases the dams are designed in solid concrete, with ample discharging capacity to pass the severest floods to be anticipated. The power stations have been developed on single-runner vertical turbine installations, varied for the different heads and to meet local conditions.

A continuous profile of the river to sea level datum was run at the beginning of the field work, and forms the groundwork upon which the whole survey was developed. Recognition of the future needs of navigation has been given and provision in the permanent work for the accommodation, if necessary, of future lockage facilities at the different sites has been made.

Government Power Proposals.—(a) Slave Falls Site.—The proposed development at Slave Falls concentrates a head of 26 ft. formed by the combination of the Slave and Eight Foot Falls. The dam runs along the crest of the falls and curving downstream through an arc of about 90°, connects with the power station on the right bank of the river. Provision has been made for the future installation of a lock on the left bank.

The head and tail water elevations as at present proposed, are 928 and 902 respectively. The initial installation on which the estimate is made provides for eight 5,000-h.p. turbines, sufficient to provide for a flow of 12,000 sec.-ft. at 8/10 gate, with a spare machine for emergencies. On a 75% efficiency, 24-hour basis, 26,600 h.p. will be available at a capital cost of $93.45 per h.p. at the switchboard. The final installation provides thirteen 5,000-h.p. turbines, sufficient for a flow of 20,000 sec.-ft. at 8/10 gate with a spare machine. On a 75% efficiency, 24-hour basis, 44,400 h.p. will be available at a cost of $83.30 per h.p. at the switchboard.

(b) Seven Sisters Sites.—No detail work has as yet been possible covering the best method of development of this reach of the river. However, it is considered that it can ultimately be developed at two sites of about 34 and 37 ft. head respectively. After providing sufficient water for the plant of the Winnipeg Electric Railway Company on the Pinawa Channel, it is doubtful whether any development of the Seven Sisters Falls will be feasible until the flow of the river can be regulated to at least 20,000 sec.-ft., by means of storage in the upper waters. The power available at the 34-ft. site, under unregulated conditions, is about 11,600 h.p. and under regulated conditions, 34,800 h.p. Similarly the 37-ft. site will render available 12,600 h.p. and 30,700 h.p. respectively.

(c) McArthur Site.—At the lower of the two McArthur Falls, a head of 18 ft. awaits development. The river is here divided into two channels by a large island. The

Silver Falls, Winnipeg River.

general layout consists of a solid concrete spillway along the crest of the fall on the right or main channel, and a long spillway and embankment, including sluiceway provision, running diagonally across the island, and connecting with the power station spanning the left channel. Provision is made on the island for the future construction of a lock.

The head water elevation is at present fixed at 827, i.e., about one foot above the recorded highest water level of Lac du Bonnet. The tail-water is proposed at 809, giving a head of 18 ft.

The initial installation provides for eleven 2,500-h.p. turbines, sufficient to provide for 12,000 sec.-ft. at 8/10 gate, with a spare machine for emergency. On a 75% efficiency, 24-hr. basis, 18,400 h.p. will be available at a capital cost of $123 per h.p. at the switchboard. The

final installation provides for seventeen 2,500-h.p. units on a basis of a 20,000 sec.-ft. flow, and 75% efficiency, 24-hr. power, i.e., of 30,700 h.p. The cost per h.p. on the switchboard is $97.50. This site can be given a much more favorable aspect, when the local storage available in Lac du Bonnet (whose 32 square miles form the head-waters) is taken into consideration.

(d) Du Bonnet Site.—The proposed scheme of development at the Du Bonnet Falls will ultimately concentrate there a head of 56 ft., made up of the Grand and Little du Bonnet Falls, and the Whitemud Falls. The latter will be added by blasting out the rock bridge over which the present fall takes place. The dam, consisting of embankment, spillway and sluiceway sections, leaves the left bank and crosses the river on the brink of the Little du Bonnet Falls, connecting with the power station which parallels the right shore line below the pitch. Ice sluices and embankment connect the power station with the high land on the right bank. Provision is made for future lockage facilities on this bank.

The head-water elevation has been fixed at 808, with the tail-water at 762 previous to the blasting out of the Whitemud Falls, and 752 subsequent thereto. This secures a head of 46 ft. for the preliminary, and 56 ft. for the final installation.

The initial installation is figured on seven 10,000-h.p. turbine units, utilizing 12,000 sec.-ft. at 8/10 gate and 46-ft. head. This, on the same basis as set out above, will render available 47,100 h.p. at a capital cost of $79.40 per h.p. at the switchboard. An intermediate installation, comprising 12 units and providing capacity for 20,000 sec.-ft. at 46-ft. head, and producing 78,700 h.p., has also been estimated. The cost of the power at the switchboard for this intermediate installation is $68.90 per h.p. The final installation consists of fourteen 10,000-h.p. units, for the development of 20,000 sec.-ft. at 56-ft. head, the extra 10 ft. being secured by the removal of the Whitemud Falls. On the same basis as set out above, 95,500 24-hr. h.p. will be available at a cost of $70.70 per h.p. on the switchboard.

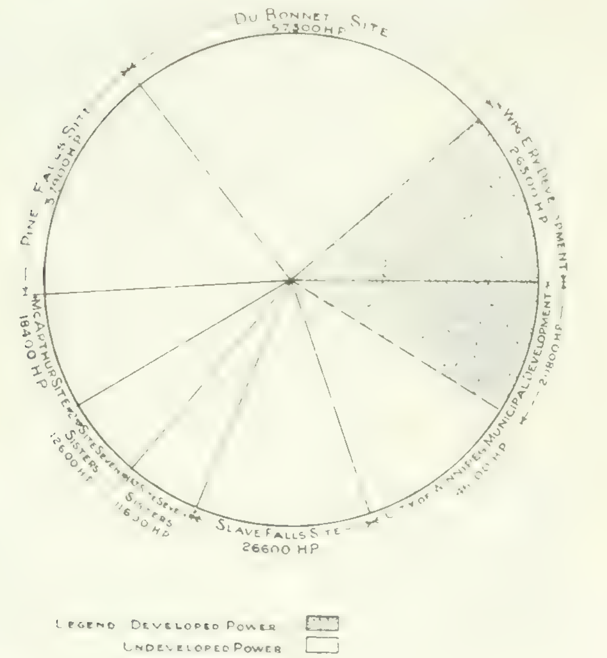
(e) Pine Falls Site.—The Pine Falls development will concentrate the natural drop of the Pine and Silver Falls, giving a head of 37 ft. The dam runs diagonally across the river from the right bank, and joins directly to the power station, which forms a continuation of the dam. The power station is connected with the high ground on the left bank, by sluices and embankment. Provision is made for lockage facilities on this bank.

The head- and tail-water elevations have been placed at 750 and 713 respectively. As the tail-water is practically Lake Winnipeg level, it will vary from year to year with the level of the lake. The installation in the power station has not been finally determined, but the following estimates of the capital cost of the power are considered to be fairly close. The initial installation will provide for the development of 12,000 sec.-ft. at 37-ft. head, i.e., 37,900 h.p. on the 75% efficiency, 24-hr. basis, at a cost of $80.30 per h.p. on the switchboard. The final installation provides for 20,000 sec.-ft., and renders available, on the above basis, 63,100 h.p. at a cost of $70.70 per h.p. on the switchboard.

Summary of the Power Possibilities of the Winnipeg River.—Fig. 4 is a tabulation of the powers, developed and undeveloped, of the Winnipeg River, under regulated and unregulated conditions. The undeveloped power is considered on a 75% efficiency, 24-hr. basis, and the capital cost per h.p. is given in terms of this power, estimated to the switchboard in the power house.

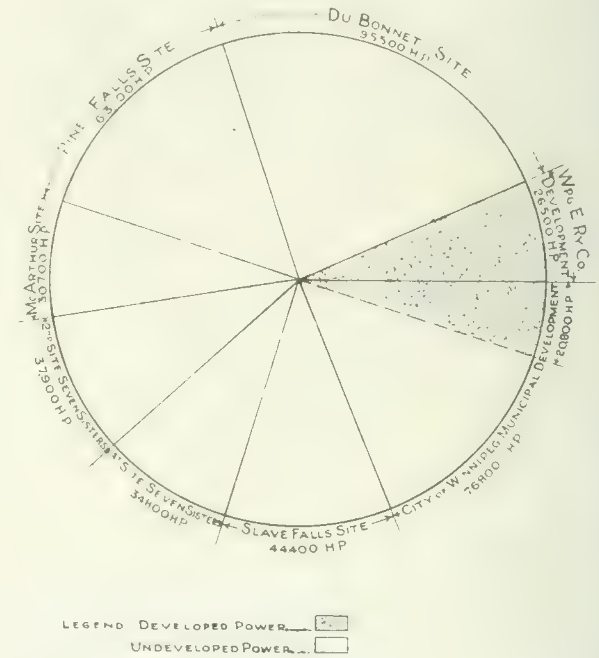
Attention is called to the circular diagrams on Figs. 5 and 6 as illustrating, in a graphical manner, the developed and undeveloped power conditions along the river under unregulated and regulated river flow.

Diagrams Showing the Developed and Undeveloped Powers at the Various Sites on the Winnipeg River. (Undeveloped Sites Considered at 75% Efficiency with 24-hour Power.)



Total power capacity of Winnipeg River without regulated flow 237000 HP
Amount developed to date 47300 HP

Fig. 5.—Based on the Unregulated Flow of 12,000 Sec.-ft.



Total power capacity of Winnipeg River with regulated flow 409,700 HP
Amount developed to date 47300 HP

Fig. 6.—Based on a Regulated Flow of 20,000 Sec.-ft.

Future Economic Value of the Winnipeg River Powers.—With regard to the future economic value of the powers of the Winnipeg River, a report was made to the Department of the Interior in September, 1911, by Mr. J. R. Freeman, one of the consulting engineers retained by the Department for advice in connection with water power matters. Mr. Freeman says:—

"**Economy and Conservation.**—While water power opportunities on the Winnipeg River may have a very few years ago appeared so far beyond possible use that ordinary economics were unnecessary, it is, I believe, plain to-day beyond serious question that all of the remaining opportunities for power should be carefully conserved and only developed under such conditions as will not necessitate any great waste or the impairment of remaining opportunities.

Second Pitch of Grand du Bonnet Falls, Winnipeg River.

"Sundry remarkable electro-chemical processes have been very recently invented, which promise to be of great future benefit to agriculture and other arts. Fertilizer for farmers' use is now being successfully made by electricity from the nitrogen of the air, and great water powers in Norway are now being developed for these purposes in addition to those already in use, and recent developments have also been made of similar processes not far from the southern boundary of Canada.

"The great uses of hydro-electric power at Niagara Falls and at the Sault, for making aluminum, carbide for gas lighting, bleaching powders, and caustic soda and sundry other important products, were unknown only a few years ago. Indeed, it may be said that every one of the electro-chemical processes now located at Niagara Falls has been invented since the first of the large hydro-electric power stations was built at that point. It is idle to say that the era of important electro-chemical invention is yet more than begun and with the many able investigators now earnestly working on these lines in many parts of the world, great additional discoveries and commercial developments in the application of cheap electric power are almost sure to come, particularly in metallurgy or the reduction of ores.

"**The Winnipeg Market Now Fully Supplied.**—The City of Winnipeg will soon have all the power that it needs for public service corporation and for any conceivable manufacturing purposes likely to locate in or near the city for perhaps a score of years to come, from the railway company's plant already in use and to-day understood to be delivering about 22,000 horse-power and from the new municipal hydro-electric power plant at Point du Bois, now nearing completion, with a first installation of 26,000 horse-power and with works planned to be extended to more than three times that capacity.

"Thus these two plants will be capable of delivering to Winnipeg more than 100,000 h.p. of 24-hour electrical energy, a quantity which can be best appreciated by a statement that it is far greater than the total water power at Lowell, Lawrence, Manchester and Holyoke combined.

"**A Possible Field for Use.**—The best use that I can foresee for the vast water powers now remaining untouched upon the Winnipeg River is as the basis for founding three or four new industrial cities based upon electro-chemical industry, very much as water power was the basis for creating, years ago, the cities of Lowell, Lawrence, Manchester, Holyoke, Bellowa Falls, and as in recent years it has brought together hundreds of new homes at Niagara Falls, Shawinigan Falls and at the Sault.

"We cannot to-day say what the line of manufacture may be, for the electro-chemical arts are still in a state of ferment and creation. It has already been demonstrated that by electric smelting, steel for the manufacture of tools can be made having a quality and value difficult to obtain otherwise. Fertilizer in the form of artificial saltpetre is being produced commercially in large quantities under German processes, while carbide, carborundum, aluminum and numerous other useful products are being made by electro-chemical means in great quantity at Niagara and elsewhere, and sooner or later the time will come when fertilizer will not be scorned by the farmers of the Canadian Northwest. There is promise of new metallurgical processes for which cheap electricity is a necessity and the price per pound of several of these products is such that they could stand a considerable cost of freighting to their markets and such that a power capable of being developed in so vast quantity at one point and at so low a cost per horse-power as appears practicable at three of the sites along the Winnipeg River, will surely be very attractive.

"**These New Industries Must Locate Close to the Water Fall.**—These electro-chemical processes, when carried on in the large commercial way, demand that the work be done close to the point where the power is generated, for two reasons: First, because although the air-saltpetre process uses alternating current at low voltage which cannot be transmitted to great distance with anything like the facility of alternating current; and second, because in order to attract these processes it is necessary that the cost per horse-power be the very lowest and not overloaded by the cost of long transmission lines or the percentage of power necessarily lost in such transmission.

"Wherever a new industrial centre with some hundred of homes can be established in the wilderness within a hundred miles of Winnipeg, it will add to Winnipeg's prosperity in a degree but little less than if located within its borders and will add to the prosperity of the province by the new opportunities that it brings for employment, the diversity that it adds to its business interests and by the money that it will put into circulation. It is plain that many of the recent power developments made in various parts of America, from which the power is transmitted long distances, to displace steam power in populous centres results in putting a much larger number of men out of work than it sets at work. Such a development is of less benefit to the country than the early water power developments which were used locally in erecting the cities already named, in building hundreds of new homes and in setting thousands of men working at new opportunities."

THE SIEVING OF CEMENT.

The determination of the degree of fineness of a sample of cement, usually a part of the specification and contract upon which the material is purchased, is an operation where accuracy of the results is often in dispute. The U.S. Bureau of Standards has recently carried out tests to ascertain what order of discrepancy may be expected when made by the standard routine method of sieving. A paper by Rudolph J. Wig and J. C. Pearson, just published by the Bureau, gives the following conclusions as conservative estimates deduced from the results of these tests:

1. Employing the present standard method of sieving, the greatest attainable accuracy in single fineness determinations of normal Portland cement on a standard No. 200 sieve, that is, the greatest attainable accuracy in checking uniformity of samples, is about 0.2 per cent.

2. "Standard" No. 200 sieves may differ in their sieving values by considerable amounts, such that their corrections to the ideal No. 200 sieve may be at least as great as 0.7 per cent.

3. Errors of at least 0.5 per cent. may be looked for in single fineness determinations of normal cements on a standard No. 200 sieve when made in the usual routine manner.

4. Deviations exist in the sieving values of "standard" No. 100 sieves, of a magnitude, roughly, one-half the corresponding values for No. 200 sieves as given above.

5. "Personal equation" appears to be appreciable in hand sieving, as in most laboratory operations, the observed values being as great as 0.3 per cent.

6. The rating of a sieve by some system of demerits assigned from direct measurements appears to be an interesting possibility, and worthy of further study. Should a system be worked out to give reliable indications, say, within 0.2 per cent. or 0.3 per cent. of the observed sieving value of a sieve, it will add greatly to the value of the certificate now furnished with standard sieves.

It seems evident that both sieving tests and the interpretation of measurements on sieves are subject to considerable discrepancies, and the question arises as to whether some other more reliable method of determining fineness can not be made available. The sieve at best is a measure of the coarseness of finely ground material rather than the fineness, and experiments now in progress at the Bureau of Standards indicate that air separation will offer a more satisfactory means of determining fineness than mechanical sieving.

It may be stated that a tolerance of 1 per cent. from the specification should be allowed with the No. 200 sieve and 0.5 per cent. from the specification with the No. 100 sieve, every care being taken to conduct the test in strict accordance with standard methods. These tolerances should be considered as minimum values since they are based upon the results obtained by careful and experienced observers; therefore it should be emphasized that greater differences are possible in ordinary routine testing.

Scope of the Tests.—Discrepancies in determinations of fineness may be attributed to: (*a*) Differences in the standard sieves; (*b*) the "personal equation" of the observer; (*c*) lack of uniformity in the samples; (*d*) the residual differences when the three foregoing sources of error are, as far as possible, eliminated.

Considering the last mentioned first, it is evident that the experienced and careful worker, using a high-grade sieve and sieving samples of a well-dried and thoroughly mixed cement according to a fixed program, can by repeated trials determine a maximum limit of tolerance for residual differences. When this has been established, the same observer is in a position to check uniformity of samples of other cements—that is, he may check their uniformity only with an accuracy not greater than his own maximum limit of tolerance. There is at present, so far as we know, no simpler method of detecting lack of uniformity in finely ground material.

Following the results reported below, an attempt has been made to establish:—

1. What variations in fineness determinations are permissible under the most favorable conditions.

2. What variations may arise from differences in the "standard" sieves themselves.

3. What error may be looked for in a single fineness determination on a standard sieve as performed by an ordinary laboratory worker of average experience.

4. Whether variations from the standard method of sieving are appreciable.

5. Whether "personal equation" is appreciable in the limited number of tests made.

6. Whether an arbitrary system of "demerits" determined from careful measurements of a sieve is a reliable indication of its sieving value.

Features of the Tests.—The tests were made on a lot of sieves submitted for the purpose by two well-known firms. Four men made independent determinations of fineness on 24 of the sieves, while two men made the majority of determinations on the remaining sieves. The cement used was a good brand of normal grade Portland, which was first thoroughly dried, screened through a No. 20 sieve, and finally mixed by long-continued rolling on a large sheet of stout manilla wrapping paper. The determinations were made according to the standard method of sieving described in the United States Government Specification for Portland Cement, as follows:

The determination of fineness should be made on a 50-gram sample, which may be dried at a temperature of 100° C. (212° F.) prior to sifting. The coarsely screened sample (cement is ordinarily screened through a No. 20 sieve before mixing for routine tests) should be weighed and placed on the No. 200 sieve, which, with the pan and cover attached, should be held in one hand in a slightly inclined position and moved forward and backward in the plane of inclination, at the same time striking the side gently about two hundred times per minute against the palm of the other hand on the upstroke. The operation is to be continued until not more than 0.05 grams will pass through in one minute.

While the experienced worker always develops some peculiarity in his method of sifting, which contributes to or determines his "personal equation," undoubtedly the chief factor to be guarded against is carelessness. This factor may explain to some extent the rather wide variations observed, but it may be safely assumed that the sum total of carelessness on the part of those who participated in the tests is less, rather than greater, than that made in normal routine work, and it is believed that the average results represent what may be expected from experienced routine workers in similar laboratories.

In the following tables the observers are designated by letters and the sieves by numbers:

Table I.—Results of Sieving Tests Made by Four Observers on 12 Standard No. 200 Sieves.

Sieve.	Observers. A	B	C	D	E	Average.	Max. var. from average
1	80.30	79.72	80.40	80.24	.....	80.16	0.44
2	79.88	80.66	80.20	80.46	.....	80.30	.42
3	79.78	80.44	80.44 80.44	.....	80.51	80.32	.54
4	80.62	80.00	80.44	80.76	.....	80.46	.46
5	80.50	80.72	80.18	80.56	.....	80.49	.31
6	80.24	80.84	80.66	80.36	.....	80.52	.32
7	80.40	80.57	80.44	80.80	.....	80.55	.25
8	80.30	80.82	80.26	81.14	.....	80.63	.51
9	80.34	80.90	80.72	81.04	.....	80.75	.41
10	80.56	80.76	80.90	81.50	.....	80.93	.57
11	80.42	80.40	81.36	81.60	.....	80.94	.66
12	81.04	81.00	80.76	81.34	.....	81.03	.31
Average.	80.36	80.57	80.55	80.89	.....	80.59	.43
Personal equation.	+.23	+.02	+.04	—.29	.....	.....	...

Table II.—Results of Sieving Tests Made by One Observer on One Standard Sieve Using Five Different Methods.

Trial	1 (200 strokes)	2 (250 strokes)	3 (150 strokes)	4 (Single washer)	5 (6 steel balls)
1	80.30	80.06	80.44	79.76	80.36
2	80.44	80.08	80.36	79.46	79.98
3	80.16	80.02	80.24	80.08	80.18
Average....	80.30	80.05	80.35	79.77	80.17

Table I. shows the results obtained by four observers using the same cement on 12 standard No. 200 sieves. The figures are percentages of total cement passing the sieves.

An approximate value of the range that may be expected due to differences in the sieves may be obtained from the averages for each sieve, which are taken as the most probable sieving values. The highest is seen to be 81.03 per cent., the lowest 80.16 per cent., range 0.87 per cent. A "standard" sieve according to these results, may therefore differ from the mean value of a number of good sieves by nearly 0.5 per cent. It is to be borne in mind, however, that the mean value of a number of good sieves will generally be greater than the amount passed by an ideal No. 200 sieve, since the prescribed limits of tolerance allow greater latitude below 200 meshes than above. Thus, careful measurements of cloth on sieve No. 1 showed this to be the nearest of the lot to the ideal No. 200 sieve, and repeated fineness determinations with this sieve showed that its most probable sieving value was about 80.30 per cent., which is 0.3 per cent. less than the observed average value for all the sieves. It follows, therefore, that a "standard" sieve may have a true correction to the ideal sieve of as much as 0.7 per cent.

The last column of Table I. shows that the error to be looked for in a single fineness determination is likely to be at least 0.5 per cent., a figure which will, of course, vary with the reliability of the observer. A search through Table I, however, will show that all the observers have missed the average value on one or more sieves by more than 0.4 per cent.

A roughly approximate value of personal equation may be obtained by averaging all the determinations made by each observer and comparing this with the mean value of all observers. The values are given in the last line of Table I. The number of observers is too small to establish this factor with any certainty, but for observers A and D, whose averages show appreciable deviations from the others, it may be noted that 8 times out of 12 A's value is less than the mean value for the sieves, and 8 times out of 12 D's value is greater than the mean value for the sieves.

Table 2 represents the results obtained by a single observer on sieve No. 1, using five slightly varying methods of sieving, each method being given three careful trials. These methods include the deviations from the standard method of sieving which are sometimes permitted in fineness determinations. Col. 1 contains the results obtained by moving the sieve back and forth 200 times per minute, that is, according to the standard specifications. Col. 2 contains the results obtained from sieving at the rate of 250 strokes per minute, this rate requiring, of course, short quick strokes. Similarly Col. 3 contains the results obtained by sieving at the rate of 150 strokes per min., the strokes being relatively long and slow. Col. 4 contains the results obtained by sieving according to standard specifications, using, however, a single brass washer about ¾ in. in diam. to aid in breaking up the small lumps of fine material. Col. 5 shows the effect of using six 3/16-in. steel balls in place of the washer.

While the determinations are too few in number to show decided differences, the order in which the results actually occur is interesting. From the lowest to the highest amounts passing the sieve, the order is as follows:—

1. Sieving with a washer on the sieve.
2. Sieving with steel balls on the sieve.
3. Sieving at 250 strokes per min.
4. Sieving at 200 strokes per min.
5. Sieving at 150 strokes per min.

Thus the trials indicate that the simplest and easiest method—that is, sieving at the moderate rate of about 150 strokes per minute—gives the maximum percentage of cement passing the sieve. The somewhat erratic results obtained by the use of the washer and the balls, which might have been anticipated to give the highest values, are seen to be the lowest; and the variations are to be accounted for by the uncertainty of the stopping point. The use of washer and balls seems to increase the irregularity of the amounts obtained in successive minutes toward the end of the sieving, so that one may naturally stop somewhat earlier than he would if the amounts were decreasing regularly. It is evident, of course, that for every minute over or under sieving, the error introduced is approximately 0.1 per cent. On this basis the maximum limit of tolerance for the best work can hardly be less than 0.2 per cent., since the most careful observer may readily be one minute short or one minute over.

The fact that appreciably more cement passes the sieve at 150 strokes per minute than at 250 strokes per minute is no doubt due to the more rapid horizontal motion of the sieve in the latter case, whereby particles just under the smallest size retained have less opportunity to fall through the sieve openings than when the sieve is moving at the slower rate.

In all sieving tests it is tacitly assumed that the specifications need not be closely followed until the greater part of the fine material has already been sieved through, that is, the final result is assumed to be independent of the manner in which the first part of the sieving has been performed. This is no doubt justified in

hand sieving when no washers or balls are used to hasten the process, but one may well question the assumption when vigorous methods are used, as in most routine work. In all trials reported in Table 2, the specifications were followed throughout the entire time of sieving.

It may, of course, be possible to form an estimate of the relative sieving value of a sieve from the direct measurements made upon it of the number and diameters of the warp and shoot wires, and the uniformity of spacing of the wires. The establishment, however, of a hard and fast demerit system for calculating the sieving value involves much guesswork, and the attempts thus far made at the Bureau of Standards to devise such a system have been only partially successful. It is not, therefore, worth while to go into the details of the manner in which the demerits have been assigned other than to state that consideration was given to all factors which affect the variations in size and distribution of the openings.

Table III.—Relation Between Value of Sieves as Actually Tested and Estimated Value Based on Sieve Measurements.

Sieve.	Sieve value.	Demerits.	Sieve.	Sieve value.	Demerits.
1....	80.16	— 408	7....	80.55	— 548
2....	80.30	+1312	8....	80.63	—1386
3....	80.32	+1304	9....	80.75	— 188
4....	80.46	—2363	10....	80.93	—1573
5....	80.49	—1101	11....	80.94	—2340
6....	80.52	—1150	12....	81.03	—3135

Table III. gives the average sieving values of the sieves listed in Table I., together with their demerits arbitrarily assigned from analysis of direct cloth measurements on the sieves.

Table IV.—Results of Sieving Tests Made by Four Observers on 12 Standard No. 100 Sieves.

Sieve.	Observers. A	B	C	D	E	Average	Max. var. from average.
1	96.28	96.48	96.44	96.64	.....	96.46	0.18
2 ..	96.24	96.50	96.58	96.70	.....	96.50	.26
3	96,22	96.48	96.44	.....	96.86	96.50	.36
4	96.46	96.50	96.42	96.70	.....	96.52	.18
5 ...	96.32	96.58	96.48	96.72	....	96.52	.20
6	96.30	96.74	96.50	96.68	....	96.56	.26
7 ...	96.52	96.68	96.52	96.44	96.74	96.58	.14
8	96.48	96.56	96.58	96.74	....	96.59	.15
9	96.54	96.60	96.56	96.66	.....	96.59	.07
10	96.54	96.48	96.42	96.90	.....	96.59	.31
11	96.64	96.64	96.72	96.64	....	96.66	.06
12	96.59	96.68	96.68	96.96	....	96.73	.23
Average.	96.42	96.58	96.53	96.71	....	96.56	.20
Personal equation	—.13	.02	+.03	—.15	....	.....	...

Table IV. is similar to Table I., containing the results obtained by four observers using 12 "standard" No. 100 sieves. The same method of examination enables us to state that a single determination of fineness on the No. 100 sieve is likely to be at least 0.2 of 1 per cent. in error. This value is, of course, less than the corresponding value for the No. 200 sieve, owing to the smaller quantity of material of this grade, which therefore gives a more definite stopping point in the sieving. Similarly, the range of differences that may be expected between standard sieves is less than that for the No. 200 sieves, being in this case from 96.46 per cent. to 96.73 per cent., of 0.27 per cent. The maximum correction of a "standard" No. 100 sieve to the ideal No. 100 sieve therefore appears to be of the order of 0.2 per cent.

A striking agreement is also noted between the "personal equations" as given in Tables I. and IV., the operators being the same in each case.

SUPPORTING TRACKS DURING CONSTRUCTION WORK.

The bearing on the total cost of work which is had by the design and construction of temporary structures supporting railway tracks under traffic, while work proceeds underneath—for instance, in the building of street or highway undercrossings—was shown at the recent convention of the American Railway Bridge and Building Association. Work was described at various points on the lines of the Lake Shore and Michigan Southern Railway, where three systems of support were successively required as the work proceeded.

At Sandusky, Ohio, a street crossing seven tracks at grade was to be carried under without altering the track profile. The solid rock surface was about halfway down and above this were boulders and hardpan. Pile bents were built, the piles being driven to a stop. In the floor system supporting the tracks were incorporated two sets of stringers, one spanning from bent to bent and the other balanced on the bents. As the excavation proceeded ridges were left to protect the piles, the intervening spaces being taken out to solid rock. Some of the piles were found broken, and in such cases short posts on sills were pushed in to replace them. When the rock surface between bents had been reached frame bents were erected in the middle of the spaces, catching the ends of the secondary system of stringers, which, like the primary system, were designed to carry the full load. The pile bents were then removed, except the caps, which were left bolted to the stringers; then the remainder of the loose material was cleaned away and trenches cut to the full depth required for the excavation, the trenches being directly in the line of the original pile bents and the whole system being so spaced as to avoid the permanent abutments and the intermediate piers. New frame bents were then constructed in the trenches and the load transferred to them, after which the bents on the higher level were in turn removed.

A somewhat different treatment was required at Cleveland, where a street crossed six tracks at grade on a sharp skew. There, as at Sandusky, it was proposed to cut the street under without changing the track profile, but the rock surface was only about 4 ft. below subgrade. Of the four main tracks the two inferior ones were temporarily put out of service and the soil underneath excavated to rock. Two sets of stringers were used as at Sandusky, the secondary set, however, being placed on top of instead of alongside the primary set. The stringer system thus filled most of the space between subgrade and rock, and the first system of supports consisted of sills and blocks spaced 20 ft. apart. Afterwards the procedure was similar to that at Sanduskv, the second set of bents being carried in trenches about halfway down and the third set resting on the bottom of the finished excavation.

The cost of the Panama Canal to May 30, 1913, was $295,587,418.41. For the sanitation of the Canal Zone $16,132,056 was expended.

EXPERIMENTS IN PRE-HEATING CLAYS.

IN Memoir No. 25, Geological Survey, Department of Mines, Canada, Dr. Heinrich Reis and Mr. Joseph Keele have submitted Part II. of their report on the clay and shale deposits of the Western Provinces. The 108-page book is well illustrated, and has an abundance of new data concerning the properties and characteristics of the formations to be found throughout the West. One chapter, by Mr. Keele, deals entirely with experiments in pre-heating clays, from which we make the following extracts:—

Among 120 samples of clay and shales collected during the seasons of 1910-11 in the Great Plains region, 28 of them, or about 23%, cracked in air drying after being moulded. These defective clays occur principally in the Belly River and Edmonton formations, and in the upper part of the Cretaceous, but some of the Laramie clays have the same fault.

They are frequently found in localities well situated for transportation; they are easily worked, and occur in great abundance. They would, therefore, be of great economic importance if they could be utilized, as many of them will make fireproofing, and some even can, we believe, be manufactured into sewer-pipe if their tendency to crack while drying can be overcome.

Several beds of these clays and shales could be manufactured into facing bricks by the dry-press method, but it is impossible to use them for the many important structural wares which involve the use of the wet-moulded processes.

During the progress of the laboratory work on the samples of these clays collected in the field, the writer was confronted with the difficulty of preparing test pieces from them for the purpose of observing their behavior under fire. The clays absorbed a great deal of water in tempering, afterwards forming a stiff pasty mass which was tough and sticky and hard to work. Shortly after being set to dry the moulded shapes cracked, even small test pieces splitting badly in the ordinary laboratory temperature. The surface of a full-sized brick readily became dry, and developed a perfect network of cracks, which deepened and widened as drying progressed, while the inside remained moist for several days. The use of substances which would coagulate the clay was tried to cure this cracking, being careful to use materials which were cheap and readily available, so that if the remedy were successful it could be used on a commercial scale. Of the various acids and alkalis tried, common salt to the amount of 1% added to the clay seemed to give the best results. The salt kept the surface of the bricklets moist while the water was working its way out of the body.

Full-sized bricks made from some clays thus treated would dry safely in the ordinary room temperature, but many clays would not, and few of the salted clays would stand even moderately fast drying. Furthermore, the stickiness and soap-like qualities of the clays were not ameliorated to any appreciable extent by the mixture.

The next method which suggests itself was the use of non-plastic materials like sand or grog. River sand, ground quartz, and calcined clay were successively used. These were added to the clays in varying amounts up to 50%.

The mixtures with sand failed in every respect, and although the grogged clay could be safely dried in some instances, and burned to a good body, the bad-working qualities of the raw clay were still in evidence.

Professor Orton,* who was experimenting on some clays of the Edmonton series at the same time as the writer, was unsuccessful in overcoming their drying defects by the use of either chemical coagulants, or additions of non-plastic materials. There remained then the method described by Professor A. V. Bleininger for treating clays that cracked in drying, by pre-heating them at various temperatures.

Pre-heating experiments were done on several of our clays, and the results arrived at seem to prove that this is the best method so far, for dealing with the difficulty. The data for six samples of clay from localities widely apart are here given. Clays of these types may be expected to recur frequently in other localities throughout the region we are dealing with. Numbers 1644 and 1755 are used for making dry-pressed bricks, but the other samples are from unused deposits.

1644—Dark grey massive clay, underlying a lignite seam, Estevan, Sask.

1755—Light grey massive clay, Coleridge, Alta.

1765—Dark grey soft shale, underlying a lignite seam, Tofield, Alta.

1675—Light grey hard shale, overlying coal seam, Oldman River, Alta.

1800—Soft olive shale, Gwynne, Alta.

1796—Soft shales interbedded with streaks of sand, Camrose, Alta.

The clays were heated in a small rotary drum, made of sheet iron, and having baffles projecting from the inside to keep the clay well stirred up and evenly heated.

A stationary sheet iron hood enveloped the drum except where openings were left for the gas flames to enter. The drum, which was revolved by hand, was provided with a hollow axle, through which a pyrometer tube was inserted. About ½ to ¾ hr. was generally taken to bring the clay to the required temperature, the latter being easily kept constant during the time allotted for treatment.

The length of time allowed at each temperature was 15 min., each clay being kept for this period at successively higher temperatures until it yielded to the treatment. Other trials were made of 30 min. duration at certain temperatures, to show the effect of time.

The latter results show that it is possible to obtain effects at lower temperatures with increased time, similar to those given in the shorter time at higher temperatures, but this appears to be true only within certain limits, as Professor Orton's experiments show that some of these clays were not improved by exposure for 1½ hrs. to a temperature of 400° C. Steam was given off freely from the heated clay at all temperatures up to 500° C. The fumes evolved at higher temperatures smelled strongly of sulphur and hydrocarbons, which was probably due to the dissociation of particles of pyrite and driving off of bituminous matter.

When the heating was completed all the clays except No. 2 were much darker in color than in the raw state, being dark grey to almost black.

Clay No. 1755 yielded at a comparatively low degree of heat treatment, probably due to its containing a relatively larger amount of grains larger than clay substance than any other of the samples tested.

The tenacity with which clay No. 1765 clings to its plasticity under the action of heat is remarkable, as that property was not affected to any great extent even at the

*Edward Orton, Jr., Experiments on the drying of certain Tertiary clays, Trans. Am. Cer. Soc., Vol. XIII.

highest limits of the experiment. It would no doubt succumb to a more prolonged exposure at 550°. or it might be successfully treated at 600° for 15 min. The latter was not tried, however, as it is possible that the amount of preliminary heating that could be economically applied to this or similar clays in practice was already exceeded.

Clays Heated in Rotary Drum.

No.		400° C. 15 min.	450° C. 15 min.	500° C. 15 min.	500° C. 30 min.	550° C. 15 min.	550 C. 30 min.
	Drying at 65°C.				Bad	Improved	Good.
1644	" 30°C.				Bad	Good	Good.
	Plasticity				Good	Fair	Low.
	Drying at 65°C.	Good					
1755	" 30°C.	Good					
	Plasticity	Fair					
	Drying at 65°C.					Bad	Bad.
1765	" 30°C.					Bad	Good.
	Plasticity					Good	Fair.
	Drying at 65°C.					Bad	
1765	" 30°C.					Bad	
	Plasticity					Good	None.
	Drying at 65°C.				Bad	Improved	
1800	" 30°C.				Bad	Good	
	Plasticity				Good	Fair	None.
	Drying at 65°C.		Bad				
1706	" 30°C.		Bad				
	Plasticity		Good	None			

The results given by sample 1675 show the slight margin in time that exists between the proper and unsuccessful handling of some clays.

After the 30-min. treatment at 550° this clay was sandy in texture, and could not be moulded into shape, while after the 15-min. treatment its defective qualities were quite unimpaired.

The precise time, then, for the clay at this temperature appears to be either 20 or 25 min., but. as will be explained later, the 30-min. treatment was not fatal.

The results of previous experience without any special apparatus, showed that the clays would require a high degree of heat treatment, but to avoid mistakes all the clays were heated to 350° C.; however, since no change occurred in any sample at this temperature it is unnecessary to include it in the table.

The test pieces made up for the drying tests were 2½-in. cubes, as there was not a sufficient quantity of the various clays in stock to make full-sized bricks. The cube, however, has a greater volume for the amount of surface than any of the brick shapes.

The driers used in the experiment consisted of small chambers attached to the steam heating apparatus of the building. The maximum temperature that could be obtained in this way was about 65° C., the pieces being dried in from 24 to 36 hrs. Although faster driers are used for some clays in practice, it was decided that if the clays can be worked and afterwards dried safely at the above temperature, that the object of the experiments had been attained.

The pre-heating causes marked changes in the character of the clay, the most important for practical purposes being the change from a tough sticky mass, having undue shrinkage and abnormal cracking in drying, to an open granular body which can be easily worked and rapidly dried.

The pre-heated clays require considerably less water for mixing than the raw clays, consequently the air shrinkage in the clays thus treated is greatly reduced, as shown in the following table:

No.	Average per cent. air shrinkage. Raw clay.	Pre-heated clay.
1644	9.6	4.0
1755	7.0	0.0
1765	8.7	5.0
1675	8.9	5.0
1800	8.5	3.6
1796	8.8	4.0

Another striking advantage gained in pre-heating is seen when burning the test pieces. Those clays which were subject to black coring and swelling were completely cured of this trouble by the pre-heating treatment. This is probably due to the change in texture which the clay undergoes when pre-heated, giving a more open body from which the gases evolved in burning can escape freely, and also to the driving off of some of the carbonaceous and sulphurous components.

The effects obtained by pre-heating to the above temperatures are not permanent.

The plasticity of the clays Nos. 1675 and 1800, apparently destroyed during the course of the experiments, was restored again by allowing those clays to remain in an excess of water for 24 hrs. Sufficient water was then evaporated, so that the clay could be remoulded, and set to dry. No. 1675 would still stand fast drying, but No. 6 cracked both in the fast and slow drier.

Again, when the cubes made from No. 6 were dried, reground and wetted for the third time it was found that this clay had regained all its pristine plasticity and stickiness, and small bricklets then made from it cracked while air drying at room temperature quite as badly as the raw clay did.

Analyses of Clays Which Cracked in Drying.

	No. 1755.	No. 1765.	Bentonite from Camrose.
Total silica (SiO_2)	74.25	65.23	69.14
Alumina (Al_2O_3)	14.29	18.60	14.50
Oxide of iron (Fe_2O_3)	2.89	2.97	2.56
Lime (CaO)	0.37	0.66	2.45
Magnesia (MgO)	Trace	0.64	1.14
Potash (K_2O)	2.52	2.40	0.19
Soda (Na_2O)	1.19	2.23	1.25
Loss on ignition	4.21	7.30	7.71
	99.72	100.03	98.95
Supplemental determinations—			
Organic carbon	not determ'ed	1.44	not determ'ed
Carbon dioxide (CO_2)	none	0.42	0.52
Sulphur trioxide (SO_3)	none	none	1.70
Hydrous silica	0.43	0.51	21.03
Sulphur	none	none	not determ'ed

In the table given above will be found analyses of several of the clays described in this chapter. They were made by G. E. F. Lundell.

The greater part of these clays is made up of quartz grains of varying degrees of fineness, as many clays are, and the chemical analysis furnished no clue to their erratic behavior.

About 20 ft. below the beds from which sample No. 1796 was taken a seam of about 2 ft. in thickness of the clay known as bentonite occurs. This variety of clay is of yellow color when fresh from the bank, but assumes a dirty white color on exposure. It is fine in texture, exceedingly smooth, and forms a very soft soapy mass when mixed with an excess of water. It has an extraordinary capacity for absorbing moisture, being capable of taking up three times its weight in water.

The clay possesses marked detergent properties, and was used in the early days of the North-West by Indians and Hudson's Bay Co. employees as a substitute for soap.

This material was rejected as unfit for any burned clay wares, but an attempt was made to dry some bricklets made from it, in a moist atmosphere. After three weeks of gradual drying the bricklets showed abnormal cracking and very high shrinkage. Although none were observed on the outcrop, it is possible that some thin streaks of bentonite were included in the beds sampled for No. 1800. Certain of the sand beds of the vicinity were found to possess plasticity, and some decidedly silty beds will crack in slow drying.

As a good deal of the material which composes these beds is derived from the erosion of the lower Cretaceous which contains bentonite beds, it may be assumed that this material, being part of the product of erosion, was re-deposited and distributed through many of the later beds.

It occurred to the writer that some simple scheme of washing might be adopted to separate out the pasty constituent from these clays.

As an experiment, one pound of ground shales from sample No. 1675 was well stirred up in about a gallon of water and allowed to settle for two hours, the water and suspended matter being then drawn off. This operation was repeated, and the residue allowed to dry. When the residue had dried, it was found to consist of a badly cracked yellow paste about half an inch in thickness, forming a crust on top of dark grey sand and silt. The yellow paste had all the appearance and characteristics of bentonite or soap clay.

The shale, when dry, was found to have lost 25% of its weight, presumably all of it being pasty matter held in suspension and drawn off with the water.

The plasticity of the shale was much reduced by the washing, but it cracked almost as badly as ever in the 65° drier. It would dry intact though, in room temperature.

That the presence of bentonite is a potent factor in producing air cracks, was proved by the following experiment. Ten per cent. of bentonite from Camrose was added to a coarsely ground paving brick shale from Elmira, N.Y. The cube made from this mixture cracked badly in the 65° drier. The Elmira shale will stand fast drying at 85° C.

Between bentonite as an extreme case and clay No. 1755 as a mild example we have clays containing varying amounts of gelatinous paste, which allows the water to escape with difficulty from the body, and causes cracking while retarding drying.

The chemical analysis of bentonite (see table) showed that it possessed a large amount of hydrous silica; which probably causes that sticky type of plasticity and the trouble in drying.

Pre-heating has the effect of driving out the water from the hydrous silica, and causing the caking together of the dehydrated particles, which gives the granular texture seen in the clays thus treated.

Clay No. 1765 was washed in a similar way to No. 1675, but lost 75% of its weight and the residue cracked in drying.

The chemical analysis made of it shows only a small amount of hydrous silica, but this clay, notwithstanding the low amount of that ingredient, possesses all the pastiness of bentonite, and its tendency to crack is almost as pronounced.

A large percentage of this clay is in a very finely divided state, and much of it may be colloidal matter; perhaps organic colloids are also present. Then, in this case, pre-heating to sufficient temperatures has the effect of driving the water from the infinitesimal pore spaces between the minute grains, and the chemically combined water from the colloids. The minute particles, when deprived of their water envelope appear to adhere in sufficient numbers to form sizable grains.

The subsequent safe drying after pre-heating seems to depend on the fact that the water with which the clay was tempered escapes by evaporation in the driers before it has time to permeate the microscopic pores again and hydrate the colloid or siliceous content.

Clays which retain or regain their plasticity after the expulsion of chemically combined water have been recorded at various times.

H. E. Kramm* found that test pieces made from mixtures of kaolin and gypsum, kept for 8 hrs. at a temperature of 790° C. slaked down in water, and had lost little or none of their original plasticity.

Most of the clays can be made workable by the preheating process if commercial conditions allow of its use. This process involves the use of a suitable type of rotary kiln, a cheap fuel to supply the high temperatures at which these clays must be treated, a proper superintendence in controlling the process and the cost of extra labor. The samples on which the experiments were made have been selected from localities in which either coal, lignite, or natural gas is abundant.

Clay No. 1644 undergoes a slight pre-heating through a rotary drier in the brickworks at Estevan. This is done primarily to prepare the clay for dry pressing by getting rid of the superfluous moisture which it contains in the bank, but the treatment was also found to stop much of the fire checking to which the raw clay was liable. The losses from fire checking are still great, but a higher degree of heat treatment would probably do away with it entirely.

It is doubtful if the kind of apparatus in use at Estevan would give a sufficiently high temperature to drive off combined water and render the clay fit for wet-moulded processes.

*Trans. Am. Cer. Soc., Vol. XIII., p. 698.

The annual report of the mines branch of the Department of Mines, issued last November, makes the statement that Canada possesses gas and oil fields of considerable value, which, if developed, may rival those of the United States. Hitherto, oil as liquid fuel has been used in North America only in the United States, and the report states that there is no reason why Canadians should not also avail themselves of its advantages. It also points out that an increasing demand for liquid fuel has of late constituted one of the outstanding features in power development; and observes that, while the oil business has generally been viewed as a gambling enterprise, and many companies have conducted it as such, the days of taking great chances are past. Dealing with the possibilities of the different Canadian provinces, the experts in the employ of the mines branch, who have compiled the report, say that in Alberta deposits are considerable, but the cost of drilling is high. Of the Northern Alberta field, they point out, that it has as yet produced no oil in commercial quantities. The same is true of British Columbia and Manitoba. The district between Regina and Moose Jaw and the Alberta border in Saskatchewan is reported to offer chances for oil operators. The province of Quebec gives no indication at the present time of developing fields of either petroleum or natural gas. New Brunswick oil fields, however, show considerable promise, and of Ontario, the statement is made that "the production both of petroleum and natural gas is on the decline and the total depletion of the underground supply is approaching."

SOME WATERWORKS SYSTEMS IN BRITISH COLUMBIA.

Construction of the Port Alberni Plant.

IN August, 1913, the Vancouver Wood Pipe and Tank Company completed the construction of a waterworks system for the city of Port Alberni, B.C., a contract begun in the fall of 1912. This contract was awarded in September, 1912, to the Municipal Construction Company, Limited, as the company was then known, and was for a lump sum approximating $108,000. The work was to have been completed in eight months, but owing to delays in arrival of shipments of steel for banding the continuous stave pipe, the plant was not finally ready for operation until August.

The principal features of the Port Alberni waterworks system, which is a municipally-owned enterprise, are an intake dam of crib-work and rock construction, a supply main some 7¼ miles long, and a distribution

Port Alberni Waterworks—16-in. Continuous Stave Pipe Line.

service throughout the business and residential portions of the city of some 4½ miles of 6-in. mains. The intake dam was constructed on China Creek, the source of supply, and is about 200 feet in length. A difficulty which first had to be overcome was the construction of a road for the entire distance of over seven miles from Port Alberni to the dam along the pipe line. This was through a rough, heavily timbered country, where trees 6 ft. in diameter had to be cleared away. In some parts, too, rock work of heavy character had to be undertaken, and the nature and extent of this may be learned from the fact that the amount removed in the construction of the road totalled 6,000 yards of rock and over 22,000 yards of earth.

In building this road the line was brought to grade, as the pipe was laid at one side, next the bank, so that it was readily covered with earth turned down from the slope of the bank. One important part of the work was providing for six inverted syphons, necessary because of the contour of the pipe line, which crosses several deep ravines, almost canyons in one or two cases. Here the roadway constructed had to be raised up by cribbing and filling-in—in some places to a height of 20 feet, so that the extreme curvature of the pipe might not be exceeded. To accomplish this about 30,000 lineal feet of cribbing timber was used.

The continuous stave type of construction was used in the first 26,000 feet of the supply main, the diameter being 16 inches. A portion of the line is illustrated in Fig. 1. This pipe was made of Douglas fir staves, from seasoned, clear stock, 2 x 4 in., dressed in radial section to a thickness of 1⅝ in.

One of the most important features of continuous stave pipe construction is the connecting of the ends of the staves. This is done by means of a flat metal tongue, about 2 in. wide and 1-16 in. thick, inserted in a slot sawed in the ends of the staves, and projecting at each edge just far enough to engage the side of each adjoining stave. To ensure absolute uniformity in this work the company has perfected and patented a machine by means of which the work of slotting is done with perfect accuracy. Thus the pipe goes together in such a, manner that a uniformly smooth bore is secured throughout, which is the object to be most desired in construction. In assembling this pipe, steel bands ½-in. in diam. were used, and the average spacing was 2½ in. The pipe line was marked by a great many curves as well as by the six syphons referred to, and the result of the construction is a striking demonstration of the adaptability of the continuous stave type of construction for such a water main.

Steel pipe was used for the remainder of the 7-mile main, the first 7,300 ft. from the end of the continuous stave pipe being 12 in. in diameter, and the next 5,800 ft. being 10 in. As the total head due to the elevation of the intake dam, 614 ft. above sea level, would have been too great a working pressure for the system, reducing valves were installed on the 12-in. and 10-in. portions of the main, bringing the pressure down to an average of about 110 lbs. in the city.

For the 6-in. distribution mains, wire-wound wood stave pipe, made from selected Douglas fir, was used. House services from these were installed at the time of laying the mains, under the supervision of the city engineer. Fire protection and other needs have been very adequately looked after, and Port Alberni, one of the most westerly ports in Canada, and one with an optimistic future, now that railway connection to Victoria has been completed, is well supplied with water for a population of fully 20,000 people. It is a curious bit of British Columbia history that this new port on the west coast of Vancouver Island, was the site of the first saw-mill, and really the first industry located in the province. The mill, long since removed, was erected by Capt. Stamp, of Boston.

Salmon Arm and other Water Systems.—The activities of the Vancouver Wood Pipe and Tank Company have included another water system for a British Columbia city, Salmon Arm, in the interior of the province. Here, during 1913, the company installed a complete system several miles in length.

Supply was taken from Canoe Creek, under a head of 700 feet, which was broken with a 50,000 gallon stave tank. This tank was housed in a frost-proof octagonal building. It forms the direct supply for the city service, which is designed to be extended as the needs of population demand.

In 1912, just prior to commencing the Port Alberni waterworks, the company completed a large contract for installing over 55 miles of steel distribution mains for the waterworks system of Burnaby municipality, adjoining the city of Vancouver. In the years 1910 and

1911 the same company undertook, and successfully carried out, the contract for installing the new supply main for the city of New Westminster, some 74,000 feet of steel pipe, 25 inches in diameter. This pipe was laid from a new dam built by the Vancouver Power Company at Lake Coquitlam, in the mountains just east of Burrard Inlet. (See *The Canadian Engineer*, Jan. 13th, 1914.)

Last year the company secured three patents for use in connection with the making of pipe. One of these was on a new and improved coupling, the other two on machines used in turning out the staves and pipe. In the new coupling for wire-wound wood pipe, the features are a machine-turned interior bore, to match the turned tenon on the end of each section of pipe where it is inserted; and a galvanized flat band of steel on each end, covering a portion of the sleeve coupling, which is in other makes left bare, as the winding of the wire cannot be carried to the extreme end of the sleeve. The flat band is sunk flush with the surface of the couplings, which are greatly strengthened by it. This band is an added strength to the end of each joint of pipe, which necessarily has no wire on the tenons where they are driven into the couplings. The machining of the interior of the coupling is a very important improvement, as it does away with any lack of uniformity of the staves when assembled in the work of winding, and thus it allows of a much more perfect fit in connecting up the pipe.

MICROMETER METHOD OF SURVEYING WATER ROUTES.

By Robert B. Sinclair.

FOR the purpose of pushing ahead their various enterprises, some governments and many private companies are now mapping their watercourses, not hitherto covered by the land surveyors. The work must be carried on with a considerable degree of accuracy; but the speed with which it is carried through is not by any means the least important factor, and sometimes becomes an important problem.

In obtaining the required data for the mapping, the micrometer survey has been found to produce results which compare very favorably with the triangulation method and the traverse method in accuracy, and the time which is gained is often invaluable to the parties concerned.

Established Methods.—This class of surveying can be carried on by several different methods, e.g., triangulation, the traverse and the stadia. All of these methods lack what is frequently a great essential, namely, speed. The first two of them have been tried out on numerous occasions where they have been found to be impracticable. The enormous amount of work in the making of the traverse survey may be readily apparent to anyone conversant with it. Lines must frequently be cut through the bush and the traverse carried along the shore.

The triangulation method suggests something more feasible, but to one familiar with this class of work, it can be seen that great difficulty may be encountered in obtaining points which could be sighted on, owing to the numerous bays and overhanging trees.

The stadia survey is much more adaptable than either of the other methods, but it is lacking in one necessity, viz., the accurate reading of distances of 400 ft. or over. On account of this the triangulation method must frequently be applied to the survey in order to take in the longer readings.

Hence, the advisability of using an instrument which will eliminate the possibility of error in long sights, and will read the shorter sights with the same degree of accuracy, appears obvious. Such an instrument we have in the micrometer. It has been tried out by the governments and also by the surveying departments of the different railways, and has been pronounced a most suitable instrument for this class of surveying.

In order to obtain the readings, a target is used, composed of two discs mounted on a light rod and set at varying distances apart, according to the length of the sights taken. The ordinary distances to be sighted are from 300 ft. to 1 mile. The space between targets used for these readings is about 10 ft. Nevertheless, sights of 5 miles have been read with a very fair degree of accuracy. For these sights a base line of perhaps 100 ft. is chained and the targets mounted at this distance apart.

The telescope of the micrometer is equipped with a double glass which throws two objects on the plane of the diaphragm of the instrument. The two glasses are worked in the vertical plane by a micrometer screw. When the objects coincide the vernier of the instrument reads zero. In turning the screw the glasses slide along, focusing the target at different points on the diaphragm. When the two of the target faces coincide, forming only three target faces in all, then the glasses have slid along a certain set distance, which varies each time with the increase or decrease in the space separating the instrument from the target. We see then the relation which obtains between the turning of the micrometer screw and the distance to be measured.

In order to compile a table which gives the distances in relation to the micrometer screw, a base line of perhaps one mile is chained out previous to entering the field. Distances are laid off every 100 ft. up to about 500 ft., and then at every 300 ft. or so. At these points the readings of the micrometer are noted. The screw is turned first to the left and then to the right, and the mean of the readings deduced. By this means the table of readings is taken in relation to the distances measured by the chain. Any number between the distances not noted can then be obtained by interpolation.

When this means of determining the distance is resorted to, the survey resolves itself into a very simple operation. The engineer in charge may use two targets. The main line of the traverse is kept intact and readings, spiralling in different bearings from the station points, is perhaps the more advantageous method of procedure. It might be stated in conclusion that the method is approximately 14 times as swift as the triangulation method, and compares very favorably in accuracy with any of them.

Governor Glynn announced recently at Albany, N.Y., a plan which he has formulated to increase the [illegible] state from $1,200,000 to $1,800,000 per annum. The scheme is based upon the state taking absolute charge of the 4,400 cubic feet of water per second now available at Niagara Falls under the treaty between the United States and Great Britain. It is claimed by electrical experts that this water will produce 75,000 horse-power. Mr. Glynn's policy is that the state should either develop this power itself and sell it to consumers, or sell the water to companies for generating electricity. If sold at the present wholesale price of electricity in Buffalo, $16 per horse-power, 75,000 horse-power will bring a revenue of $1,200,000 a year. If sold at the present retail prices of electricity at Buffalo, $26.50 per horse-power, 75,000 horse-power will bring a revenue of $1,800,000 a year. Governor Glynn contends also that, inasmuch as the state owns the water to be diverted from the Niagara river, the state [illegible]

CITY WATER WASTE.

"CONSERVATION," published by the Commission of Conservation, Ottawa, draws a comparison between the cities of Europe and North America with respect to consumption per capita of water, and presents some remarkable figures tending to emphasize the inordinately high waste of water in American cities.

The tables below give figures taken from representative cities on both sides of the Atlantic, and furnish a good basis for such a comparison.

	Imp. gals. per head per day.
St. John, N.B.	200
Vancouver,	160
Montreal	120
Ottawa	190
Toronto	95
Hamilton	98
New York	100
Buffalo	270
Chicago	190
Philadelphia	175
Average	159.8
Vienna, Austria	14
Ascher, Germany	24
Basel, Switzerland	40
Copenhagen, Denmark	26
Hamburg, Germany	40
London, England	36
Liverpool, England	36
Glasgow, Scotland	72
Newcastle-on-Tyne, England	33
Hull, England	38
Nuneaton, England	18
Stirling, Scotland	53
Riga, Russia	21
Manchester, England	42
Devonport, England	40
Average	35.5

It will be seen from the above that the average consumption per head in America is between three and four times what it is in Europe. This tremendous difference can only be accounted for by assuming that the greater portion of the water consumed in New World cities is simply wasted. A consumption of 50 gallons per head per day ought to be ample for all purposes, and would still be about 43 per cent. greater than the European average. Taking the American average as 150 gallons, we see that cities on this side of the Atlantic are using 100 gallons per head per day more than is necessary.

This unnecessary waste increases the cities' financial burdens in many ways. The pumping and filtration plants must be of needlessly large capacity; far more power must be employed to force a large quantity of useless water through the mains; and the distribution pipes and also the sewers that carry the water away, must both be bigger than necessary. Mr. R. O. Wynne-Roberts, M. Inst. C.E., estimates that in a city of 250,000 population, the extra cost of water delivered would amount to $560,000, or $2,24 per inhabitant. Further, the difference in cost of sewerage and sewage disposal would be $420,000, or $1.67 per inhabitant. This means that the city's water rates are increased by $3.91 for every man, woman and child of the population, without any appreciable benefit being gained for the extra outlay.

Undoubtedly some of this waste could be eliminated by placing meters on all house services, and, indeed, this is a common practice in England, and has already been adopted by some United States cities. To avoid the cost of installing meters on each service and to detect leaks in the mains, Mr. Wynne-Roberts suggests that meters be placed on the mains in different parts of the city, so that the quantity consumed in various districts could be ascertained. This would localize waste, and, if combined with an efficient system of inspection, would materially reduce useless consumption at a less cost than metering all house services. For a city of 250,000, he considers that about twenty district meters would suffice, the estimates the cost as follows:—

15 per cent. interest and depreciation on meters	$ 7,500
20 inspectors at $1,200	24,000
1 superintendent	2,400
2 clerks	1,920
Rent, light, stationery and miscellaneous	2,000
	$37.820

or approximately $40,000 per annum.

Certainly some means should be taken to check the present reckless waste. If some cities would conserve their present water supply, there would be no necessity of new reservoirs and additional water supply for many years to come.

CANADIAN STEEL MANUFACTURING.

Engineering, London, England, contained an article recently on the steel situation in Canada, and a short history of its growth. To quote, the writer says:—

"It would almost appear that, if the present rate of progress in steel manufacture continues, Canada will be able soon, not only to supply her own wants as regards steel, but also be able to enter the markets of the world.

"Prior to 1902, Canada made very little steel. The output advanced from 26,084 gross tons in 1901 to 182,037 gross tons in 1902. Five years later, in 1907, it had reached 646,754 tons, and five years later still, in 1912, it increased to 853,031 tons, the largest output in its history. It is quite probable that in the present year Canada will make nearly 1,000,000 tons of steel, or more than the United States made in 1879. The steel output of Canada is largely in the form of ingots, over 96% of the total in 1912 being in this form, and less than 4% in the form of direct castings.

"The largest two centres for steel in the Dominion are Ontario and Nova Scotia. In 1909 Nova Scotia led Ontario by 28,201 tons, in 1910 by 11,943 tons, and in 1911 by 20,623 tons. In 1912, however, Ontario forged ahead by 1321 tons. Nova Scotia has within its borders the new and modern plant of the Dominion Steel Corporation, while Ontario has within its boundaries the large and modern plant of the Algoma Steel Corporation.

"Naturally, the output of finished rolled forms of iron and steel in Canada increased in the same ratio as steel ingots and castings. In 1902 the total rolled output was 161,485 tons. In 1907 it had increased to 600,179 tons, and in 1912 to 861,224 tons, the maximum. Much the larger part of the total was steel—about 87.5% in 1912. Rails formed almost one-half of the total rolled output of the Dominion in 1912 over 40.2%.

"It was not till 1902 that Canada began to manufacture steel rails on a large scale. In that year it made 33,950 tons. Its output in previous years had seldom exceeded 800 or 900 tons. In 1912 the rail output reached 423,885 tons, its best yearly record."

The Canadian Engineer

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The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

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WATER POTENTIALITIES OF BRITISH COLUMBIA.

The investigation of the Commission of Conservation into the power possibilities of the rivers and lakes of British Columbia was dealt with to some length at the fifth annual meeting of the Commission in Ottawa last month. The chairman, Hon. Clifford Sifton, in his address outlined the progressive steps from the beginning of the work in the Kootenay district in 1911, to the present. It was announced that the amount already done covers that portion of the Province between the Grand Trunk Pacific line and the International Boundary, including Vancouver Island. The assembled data on this part are being prepared for publication and will be issued during the present year.

British Columbia has contributed the most difficult problems with which the Commission has yet had to contend in its water-power study. Physical difficulties, causing unavoidably slow progress in survey work, have prolonged operations. Brevity of season during which profitable advancement can be made in reconnaissance investigation, lack of facilities for rapid movement over routes or from one route to another, and heavy expenses throughout, have also been factors occasioning more labor than one is apt to credit to such a great undertaking. One of the serious difficulties encountered, for instance, is that it is almost impossible for observers to avoid over-recording power possibilities of streams observed during high stages, and the flood stages in this province frequently occur much later in the year than in eastern Canada. The conditions affecting powers in this province are unique and do not closely correspond to those existent in other portions of the country. Glaciers, melting snow, and heavy rainfall abound, especially on the north mainland coast. Many storage possibilities, known and unknown, exist. While such factors contribute to enhance the value of powers, these conditions require special and very careful engineering investigation and expert handling in order to avoid encouraging developments that might not prove economical.

British Columbia has a number of streams which cross, and some of which recross, the International Boundary, and in connection with the utilization of these waters, there may be questions requiring consideration by the International Joint Commission. Some of these streams have large power potentialities.

The construction of railways in the lower portions of valleys debars development of many of what would otherwise have been fine water-powers, and, in some instances, highways have been constructed in locations which also tend to prevent development.

Incidentally, the protection of great fisheries dependent upon inland waters arises in this connection. An instance, witnessed last summer, of great numbers of salmon dying in the Fraser river, because of artificial blocking through railway blasting, has shown how carefully matters must be considered which may possibly affect the ingress and egress of valuable fish.

The report will also include references to the British Columbia law relating to waters, to various procedures under the law, and other cognate matters. The water legislation of British Columbia is quite advanced and has attracted international attention. *The Canadian Engineer* for January 8th, 1914, outlined the scope of a proposed bill for the formation of water municipalities for the conservation and distribution of water for irrigation purposes.

BUSINESS TRAINING FOR ENGINEERS.

It is not often that engineers are afforded such a clear analysis of the status of the profession in the public mind as Mr. Porter gives in his paper on page 320 of this issue. It is a subject about which much has been written. Engineers are constantly being offered opportunities for making introspective diagnoses of their professional qualifications.

There should be no resentment, however. There has never been an age when capable engineering talent was more in demand than the one in which we live. Present day problems in rural and urban development are not as simple of solution as they used to be. Besides the increase of necessities, the insistent demand for more rapid growth, greater undertakings and more costly enterprises, there is an entanglement of vested rights and powers associated with every problem. Its working out requires a talent that possesses much greater attributes than a panoramic view of engineering practice itself.

Compared with the older professions, engineering and engineering training are subjects of much controversy, and naturally so. The former are the product of old-established courses—the product of age itself, lacking which the engineering courses of to-day are without a certain coherence. This will come, but none too speedily if the criticisms which Mr. Porter cites are to be spared by the interested public.

The practical business sense, claimed to be one of the absent qualities, is undoubtedly as much the result of insufficient training as are any of the other discrepancies. Dr. Humphreys, President of Stevens Institute of Technology, a prominent engineer, and a high authority on the value of business training as a part of technical education, in one of his numerous writings, treats the subject in the following way:—

"Self-evident should be the truth of the proposition that the engineer ought to be a man of business, or at least informed of, and prepared to conform to, business conditions and business methods. When this proposition is squarely laid before them, it is self-evident to the majority of successful engineers and men of business. Business men, bankers, and manufacturers not infrequently refuse their confidence to engineers and experts as a class, because, under trial, some individuals have demonstrated their incapacity to meet business conditions; from the standpoint of the man of business their reports, advice, conclusions have required interpretation and readjustment or amendment.

"The man so far somewhat exceptional, who is able to bring to the service of his clients or associates a sound technical training, and the ability to meet business conditions proves by his comparative success the material value of this dual capacity. For the sake of the profession and the country at large it is important that this broader capacity should no longer be exceptional.

"To this end the professional educator and the engineer-student must better recognize the conditions to be met in practice. A general and definite demand on the part of the business world for engineers of such broader capacity would ensure the necessary reform in the separate schools of engineering and the university departments of applied science."

ONTARIO LAND SURVEYORS.

The Association of Ontario Land Surveyors will hold its annual dinner at the Engineers' Club, Toronto, on Wednesday evening, February 18th.

LETTER TO THE EDITOR.

Paving Streets With Creosoted Wood Block.

Sir,—Creosoted wood block paving, while comparatively new in many Canadian cities, is, in reality, not a new idea nor a new pavement. It is the result of combining two ideas, both of which in themselves had proved successful long before the first creosoted wood block pavement was laid. The ideas are: first, that of using wood as a paving material, and second, that of chemically preserving wood from decay.

For many decades wood was used as a paving material, sometimes in the form of cylindrical blocks cut from poles, best represented by the cedar block pavement. Both of these pavements gave great satisfaction because of their noiselessness and their adaptability to all kinds of traffic. But they were short-lived owing to the attacks of decay. Even in the face of this, many cities persisted in laying them because their many merits recommended them despite their lack of durability.

While wood block pavements were decaying and many cities were being forced to abandon their use for that reason alone, there was being developed a science which was destined to remove this objection to wood paving. This was the science of wood preservation. Railroads were preserving their cross ties and bridge timbers, while preserved piling, driven in the tepid waters of the Gulf of Mexico, where it was subject to the attack of the sea worm, was found to last almost indefinitely.

Many chemicals have been used to preserve wood, but only two seem to meet all requirements. They are creosote oil and chloride of zinc. Creosote oil, alone, is adapted to the preservation of wood paving blocks as, in addition to preventing decay, it also seals the pores of the wood, prevents the absorption of water, and does not leach out the blocks.

The application of timber preservation to the use of wood as a paving material has developed a street pavement which possesses more points of merit than any other material.

Many standdrds of excellence for a street paving material have been offered by writers upon this subject. The following is believed to be a fair standard by which to measure any material:—

(1) Its initial cost must not be so high as to make it unreasonable to the abutting property.

(2) Its durability must be sufficient to make its maintenance and ultimate cost low.

(3) Its surface must be smooth and hard and yet afford sufficient foothold to horses.

(4) It must be as nearly noiseless as possible, neither producing noise under traffic nor echoing other sounds.

(5) It must be so constructed as to be quickly laid and easily replaced when cuts are made.

(6) It must be of such material as to give off no dust or mud of its own creation.

(7) It must present no obstructions to cleansing, such as crevices, and be easily flushed and scrubbed.

(8) It must present a surface which offers no resistance to wheel traffic passing over it.

(9) It must not injure horses' legs and hoofs nor be injured by horses' calks or motor car traffic.

The initial cost of a pavement is an important item and yet not always as important as one might be lead to believe. In purchasing a street pavement, as in buying merchandise, the nature and length of service should be taken into consideration. The initial cost of a creosoted wood block pavement is so low as to make it reasonable for any street and the service it will give makes it the best possible investment for the property owner.

Durability is one of the prime requisites of a street pavement. Once a street is paved it is always to be a paved street. If the pavement is not durable the time will soon come when a new pavement must be paid for. The only test for durability is experience. In this regard, creosoted wood blocks have an enviable record. It is probably the only form of pavement that has never worn out or been replaced by another. Streets paved 12 or 14 years ago with this material are in as good condition today as they were the day they were opened to traffic. The splendid durability of the pavement makes its ultimate cost lower than that of any other form of pavement known.

In addition, the quality of service given by the creosoted wood block pavement is so much higher than that of any other form as to increase the advantage of the material over all others.

For that reason many cities have adopted the policy of paving down-town business streets, where traffic is tremendously heavy, with creosoted wood block. The practice was the result of the experience of London, Paris, and other European cities, and the results obtained in American cities have been fully up to expectations. The service given by the Broadway pavement in New York and several heavy traffic streets in Chicago proves the truth of this assertion. The peculiar quality to resist the effects of traffic possessed by creosoted wood blocks, placed with the grain vertical, gives the pavement first rank in point of durability.

Street pavements are laid to be travelled upon. Their chief object is to present a smooth surface for traffic and one which will bear the wheels of passing vehicles with little or no obstruction. The very purpose in view should preclude the use of any material which is not smooth and hard. Creosoted wood blocks possess this quality to a higher degree than any other material and yet afford a sufficient foothold for horses.

Every modern city is experiencing a laudable crusade against unnecessary noises within its limits. Everyone commends legislation preventing needless blowing of whistles and ringing of bells. Creosoted wood blocks make practically a noiseless pavement, frequently called the "silent pavement." Their adoption on many busy streets has resulted in increased rents for space in abutting buildings owing to the decreased noise by the traffic.

Yet, this success of a creosoted wood block pavement depends upon the way it is laid. If the blocks are laid on a solid foundation with ½ to 1 in. sand cushion and the pavement given plenty of room for expansion and pitched to prevent water getting under it, no trouble will be experienced and the pavement will be ideal. But when the pavement is laid crudely by men who are not familiar with it, trouble must always result.

When trouble of this kind does occur, it is published throughout the country by knockers, but if the actual fact, viz., that it was the crude way the pavement was laid, were known, it would be different, and people would understand why trouble has occurred. Every time a pavement heaves it is caused by the crude way the pavement was laid. Such is the case with the creosoted wood blocks laid on the Bank Street bridge at Ottawa, an account of which was published throughout Canada. It was a certainty that the pavement on the Bank Street bridge would expand and heave and that the blocks laid near the street car rail would either be loosened and come up, or break. No expansion joints had been put in the sides at each curb; the blocks had been laid too closely and instead of the blocks next to the rail having been bevelled and set right against the rail, strips of untreated timber merely had been put alongside of each rail. These strips would absorb water, expand, rot and disintegrate. The blocks were laid up tight against the strips, leaving a space of 1½ in. wide and 2 in. deep between the rail and the edge of the pavement between the tracks. During a heavy rain-storm the water would run down alongside the rail and get under the pavement, causing it to expand and heave.

The space between the pavement and the rail permits the wheels of carriages and light wagons to get into this space and loosen or tear up the blocks.

When properly laid, great success has been experienced with wood block pavements. In the large cities on this continent, each having laid hundreds of thousands of yards during the past 13 or 14 years, most of them are without any repair bills whatsoever to date. For instance, Hamilton, Ontario, has laid since 1908 over 285,000 sq. yds. and has had absolutely no repair bills. Compare this, for instantce, with the maintenance charges in Ottawa on the Bank Street pavement, from Wellington Street to Gladstone Avenue; and on the St. Patrick Street pavement from Dalhousie Street to the St. Patrick Street bridge. On the Bank Street pavement $49,848.66 was spent by the city since 1907, in addition to the maintenance expenditures made by the contractors. On the St. Patrick Street pavement, which was completed in 1911, the city spent $344.90 in 1912, and $1,696.88 in 1913; these amounts being in addition to the maintenance expenditures of the contractors.

A minor portion of these expenditures was on account of cuts for water and gas service, etc., but the cost of such cuts in dealing with a block pavement is greatly less than in dealing with a sheet asphalt pavement, such as was laid on the two streets above mentioned.

There has been considerable objection against creosoted wood block on account of Canadian climatic conditions, but when our pavements have been excellently successful in Moose Jaw, Denver, Minneapolis, Duluth and St. Paul, with a temperature running from top summer heat to from 30 to 60 deg. below zero in the winter, this point would seem to be answered by practical experience. In Ottawa, there is a properly laid pavement constructed of blocks that were merely dipped—not even properly creosoted—which has withstood Ottawa's climate for 8 or 9 years and it is in fairly good condition to-day. Several streets in Montreal have been properly laid with the dipped creosote wood blocks and these streets have been in fairly good condition with the exception of the blocks decaying on account of moisture getting beyond the point of oil.

In the city engineer's report to the council of Ottawa, he recommends the expenditure of over $3,000,000 for pavements, including merely $900,000 for permanent roads, namely, asphalt and stone blocks. In the light of statistics throughout Canada and United States, the repair bills on the remainder of the paving recommended would be enormous. Taking statistics in these countries, creosoted wood block pavements show no cost for maintenance with the exception of a few cities, and these few cities' statistics show maintenance cost almost nil. With the large amount of creosoted pavement laid on the principal streets in all of the larger cities in the United States, without having one pavement to show much of a wear over ⅛ in., should cause the engineers in the large cities of Canada to study carefully the qualities of creosote wood block pavements.

E. S. CLEMENTS,
Canada Creosoting Company.

Toronto, February 5, 1914.

THE CIVIL ENGINEER AND HIS RELATIONS TO SOCIETY.*

By Sam. G. Porter, B.A., B.S., M.Am.Soc.C.E.
Irrigation Inspecting Engineer, Dominion Government.

THE engineering profession is constantly meeting with these criticisms with regard to its members: 1st, That they are narrow in their mental training and habits. 2nd, That they are lacking in practical business sense. 3rd, That they are too little interested in the welfare of the community, or of society.

Let us ascertain what justification there is for these criticisms and how they should be met.

Narrowness.—Most engineering students confine their energies to strictly technical topics and take under protest what few subjects of general culture are forced upon them. As a consequence, they graduate and enter upon their work with little knowledge of what is termed the humanities. Having chosen a work that calls for technical skill, they naturally give their attention to the questions which will advance their usefulness and professional standing. Furthermore, their work, especially in their early years, usually leads them away from, rather than into, contact with social and commercial influences. They are pioneers, they are on the firing line, always advancing before they are permitted to enjoy the civilizing results of their own conquests. How natural it is, then, that they should acquire habits of thought and action out of sympathy with the social problems of the day—not in the sense that they are antagonistic to social and political progress, but are merely negligent and apathetic towards them.

To the extent that this habit predominates is the criticism of narrowness justified. Our profession is worthy of the highest possible respect; the possibilities of attainments in it are unlimited; a devotion to its ideals is to be encouraged; but to put it on a pedestal and overestimate its value to the exclusion of an appreciation of other things is undoubtedly a sympton of narrowness.

Lack of Business Sense.—If the first criticism is established, the second and third will naturally follow as corollaries.

Some of the qualities and conditions which have been pointed out above as tending towards narrowness, should, if properly applied, bring about the opposite result. The engineer is trained to be exact, to be accurate, to consider all the elements of a problem before arriving at a conclusion. He is in daily contact with inexorable laws. He must study nature's forces and combat or utilize them.

If, however, the exercise of these duties appeals to and develops only the technical side of his nature, a big part of the lesson is lost.

The failure of engineers to reach a high rank in practical matters and in influence is not always through want of technical attainments. More often it is through a lack of a broad outlook, an appreciation of the true proportions of things, a right perspective of practical values. The man who keeps his eyes too closely riveted to the technical problems is too apt to lose sight of the practical ones. He will not be trusted, and in fact, is not qualified to be trusted with the broader, practical questions which are usually the dominating ones. The man who solves them is the man who becomes boss.

*Read before the Calgary Branch of the Canadian Society of Civil Engineers, January 23rd, 1914.

In addition, then, to technical attainments, honesty and energy, which we will assume that most engineers have and which we will not here discuss, he must have (a) a broad outlook, (b) a right perspective of practical values, and (c) a well developed sense of personal responsibility. Without these qualities he may make a useful man, even a necessary man, but not a great man; not a leader. But if he has these qualities in addition to the first and is trained, as we presume he is, in the accurate observation and application of the laws of cause and effect, he should forge well to the front as a leader of affairs.

A Broad Outlook.—Too seldom is it the engineer who can be credited with the conception of the plans for big enterprises. Or, if he conceives them he seems to lack the leadership necessary for putting them into effect, and some trained intellect, with executive ability and a comprehensive grasp becomes the controlling brain of the head. Then the engineer is hired to work out the details of projects which others direct and benefit from.

A man of broad experience who knew whereof he spoke, said: "It is far easier to hire engineers than to hire men." Why is this true? Why do so many engineers allow themselves to be mere units in a system or cogs in a machine to be used by other men? Why, unless this second criticism is justified, have they not enough personality, enough force of character to direct and to control affairs instead of always being the hired man? Why do they not hire lawyers and financiers instead of always being hired?

It is estimated that more than 90% of the skilled labor of the world is directed by engineers. And yet the engineers are not in many cases actually the bosses. They are only hired superintendents taking their orders from the men who are blessed with this broad grasp of practical affairs and with ability for leadership.

A Right Perspective of Practical Values.—As used here "perspective" means placing things in their proper relations to each other; giving them their proper relative values. Some men never arrive at an appreciation of this essential element. They can never distinguish between the essential and the non-essential; between the fundamental and the ornamental. Unfortunately, some engineers have this failing in respect to practical, or business matters. They have no business judgment. They have no appreciation of values. They are the ones that bring upon the profession the criticism that its members are lacking in practical business sense. Of course, the same accusation is true of members of all other professions. But we are engaged here in self analysis and will not permit ourselves the satisfaction of hiding behind the faults of others.

Even if the engineer does not aim to be a commercial manager, but confines himself as a specialist strictly to the engineering branch of his profession, still his practice must be in harmony with the commercial conditions of his specialty.

Someone has defined engineering as a "compound of common sense and mathematics." This is a good definition to bear in mind.

A Sense of Personal Responsibility.—A general fault of the times, not restricted by any means to engineers, but one of which they are also guilty, is the lack of a feeling of responsibility on the part of the individual. It is an entirely too common a procedure to shift responsibility from one shoulder to another, and to get into the habit of looking upon all mistakes as being the other fellow's fault. More effort is frequently expended finding

reasons why one is entitled to be excused from doing his full duty or bearing the responsibility for a failure than in an honest effort to meet his obligations. The mental habit of self-justification for mistakes committed is an evidence of weakness of character.

Such a tendency is an outgrowth of a lack of discipline which is manifest in our modern institutions of all kinds—commercial, educational, and political. It, in turn, has grown out of an abuse of the principle of personal liberty. An extreme example is seen in the socialistic idea that has been advanced in many of our cities that one is not personally responsible for making an honest living, but is entitled to be supported by the community.

Responsibility is a cumulative quality. Coupled with discipline it makes the individual responsible to his chief, and his chief responsible not only for himself but for those under him. Thus it extends from the lowest to the highest rank, no one being excused from its operation. Without it, efficient organization is impossible.

One who is lacking in this particular quality of honesty, which has here been called the sense of personal responsibility, is not likely to acquire the full confidence of his associates. Business organization makes it necessary that one in an important executive position see most of the facts regarding the work for which he is responsible through the eyes and the brains of other men—his subordinates. The subordinate, then, must be not only accurate in his observations, but honest and loyal in his mental attitude with respect to the obligations and responsibilities which rest upon him.

Present Tendencies.—A study of the present day activities of the business world shows that the place filled by engineers is rapidly enlarging. The engineering professor is passing from the period in which mere design and construction are its sole duties, into a much broader field—and the engineer's influence will broaden accordingly. He is essentially an economist, an adjuster of business relations and investments. Commissions for appraisals, valuations and public management are calling more and more for engineering services, and in turn making the engineer more of an economist and business manager.

It is gratifying to note this tendency on the part of engineers to qualify for business administration. It is also gratifying to note that the public is beginning to recognize their worth. Some notable examples have recently occurred of the public confidence in the ability of the engineer to administer big business affairs with surer integrity and greater efficiency than can be expected through the usual political administration. The City of Dayton, Ohio, has recently created the office of City Manager, and offered Col. Goethals, Chief Engineer of the Panama Canal Commission, a salary of $25,000 a year to take the job. He declined their offer, but another engineer was appointed to the position at a salary of $12,500. The City of Ottawa has recently made a contract with Sir Alexander Binnie, the well-known English engineer, whereby it turns over to him for the remarkable fee of $400,000 the entire engineering and administrative control of the design and construction of their proposed $8,000,000 waterworks system. The point to be emphasized here is not the big fee, but the evident inference that the city recognizes the advantage of an engineering administration over a political one. Lethbridge, the first city in Western Canada to adopt the commission form of government, has just elected three commissioners, all of whom are engineers.

"A former mayor of the City of New York, in testifying before a legislative committee, made the statement that if he were to be confined in his selection of heads of departments to men who could assume their duties and be prepared at once to administer the work of the several departments efficiently without devoting a considerable part of their term of office to learning what was expected of them, he would be obliged in a large proportion of cases to name civil engineers."*

Public sentiment is steadily growing more favorable to the engineer in respect to his appointment to responsible public positions. This sentiment is being aided by the various engineering organizations of the country, especially by the American Institute of Consulting Engineers, which has been conducting an active campaign along this line. Evidence of the betterment of conditions affecting the opportunities open to engineers is also seen in the great increase within recent years of the numbers of engineers holding positions of administrative and executive responsibility with railroad companies, and with other big business corporations. A few years ago engineers were not considered practical enough to fill such offices as that of business manager or president. Now, scores of them are held creditably by engineers.

Another fact bearing on this point is the vast increase in the last few years of the amount of construction work done directly under the direction of engineers instead of the old-time "practical" contractor. Notable examples are the Panama Canal and the Los Angeles Aqueduct. The prejudice which formerly existed against engineers and kept them out of the business side of construction has so far disappeared that nearly all the big contracting firms are either entirely controlled by engineers or depend largely upon engineering advice for guidance.

All these are favorable symptoms and tend to broaden the scope of the engineer's opportunities. In recognition of the demands for competent engineer-managers, some of the engineering schools, notably the Massachusetts Institute of Technology, are offering courses in engineering management to prepare engineers for executive positions. Let us hope that a healthy progress in this direction will continue and that engineers will prove themselves able by demonstration to refute the criticism that they are lacking in practical business sense.

Citizenship.—Coming now to the last of the three criticisms—that the engineer is too little interested in the welfare of the community, or of society, there is much to be said.

Modern progress is to a large extent a monument to the engineer. He, more than any other class of men, has been responsible for the marvellous advance made during the past century. Means of transportation and communication and the development of power, are the chief factors in creating modern conditions and these are largely the work of engineers. This being the case, why do engineers occupy a position of so little prominence in the conduct of public affairs? The number of engineers who have become notable for their activities and influence in the political and social affairs of their country is few, deplorably few, in comparison with the importance of the engineer's work in modern civic life.

One reason, of course, is that they are usually employed temporarily for a specific piece of work and when it is completed they move on to something else, thus ob-

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*Extract from an address by Dr. N. P. Lewis, M.Am.Soc.C.E., on "The Engineer as a Professional Man."

taining no material footing or interest in a community. This is more generally the case than it should be. It leads to the complaint among engineers that they do not receive due praise and credit for their work. What else is to be expected when they are so quick to fade into the background and leave the lawyer and the politician not only to manage the works they create, but to mould and direct public thought.

The expenditure of public money is an important part of the administration of public affairs. It is notorious that large sums of public money are squandered on great public works because they are done in an inefficient and uneconomical way. Engineers see and recognize this more than other men. I do not mean to convey the idea that it devolves upon them to do routine professional work for the public without compensation, but a lively interest and a properly directed influence may do much to correct the evils. Their judgment should be a much more prominent factor in moulding public affairs. What is needed is a habit of mind among engineers that will cause them to take an active part in all public questions where their knowledge and experience will enable them to contribute to the common good. Let them advise the legal profession and the legislator in forming laws governing public utilities and guarding the public health. Let them become leaders in the affairs of their government and promote the highest efficiency in its work. The influence of the professional man—the man with the right professional spirit—is needed in the direction of public affairs as well as in corporate management. The professional spirit is essentially the sense of trusteeship. The professional man takes in trust the affairs of his client. It is closely akin to what I have called the sense of personal responsibility.

The great problem of the twentieth century is a social problem. The manifest tendency of the times to put more and more power into the hands of the ignorant and uneducated, while being done in the name of personal liberty, is endangering the high standards and efficiency of our institutions—a tendency towards deterioration. The engineer's training should enable him to see things as they are, to see through the shams of socialistic theories that profess to offer a cure for all the ills that society is heir to.

I close with this sentiment: "To look upon politics and public service with contempt and disgust indicates neither intelligence, wisdom, nor patriotism, but rather ingratitude and a low order of citizenship. Your country needs your very best judgment upon public questions. This is not a mere privilege, it is a duty you owe the nation in return for the benefits of citizenship."

The Scottish District of the Institution of Municipal and County Engineers have been discussing the problem of road construction, and considering in particular the question of laying down some experimental stretches with different methods of construction, so as, if possible, to obtain data showing the methods that are best suited to the climate and the traffic. Experimental road sections are to be laid down in ten different places, and in each place eight different forms of construction are to be employed contiguously. So far as possible materials obtainable in the vicinity will be used, the binding materials will be uniform, and the gradients will be practically similar. In addition, the methods of construction will be simple and cheap, and quite applicable, so far as cost is concerned, to the districts in which the experiments will be carried out. Periodical examinations of the road surfaces will be made, the wear and tear noted, and records of the climatic conditions kept.

U.S. IRON AND STEEL INDUSTRY, 1913.

THE quantity of iron ore mined in the United States in 1913 is estimated by E. P. Burchard, of the U.S. Geological Survey, to have been between 58,000,000 and 60,000,000 long tons. This estimate is based on preliminary reports from 25 of the largest iron-mining companies, which represent the principal iron-producing districts and whose combined output is about 81% of the total iron ore mined in 1912.

The average increase in output shown by these 25 companies was 8% over that for 1912, and if this increase should be maintained by all the iron companies in the United States the total output of iron ore for 1913 should reach 59,500,000 long tons. At any rate, it appears almost certain that the former high record of iron ore mined, 57,014,096 long tons in 1910, has been surpassed in 1913. The reports received for 1913 showed considerable variation in the percentage of changes in output compared with 1912, the maximum range being from a decrease of 36% to an increase of 56%. These apparently wide variations were evidently due to conditions affecting particular companies rather than to general or even local conditions of the iron-mining industry; moreover, they concerned, for the most part, the operations of companies whose production is not sufficiently great to affect largely the grand total tonnage.

In Lake Superior district, where 85% of the domestic iron ore is mined, the increase in production corresponded closely with that of the United States in general, or about 8%, thus indicating a total production for that district of about 50,000,000 long tons, compared with 46,368,878 tons in 1912. The year 1913 is therefore a record year for production and shipments in this district also. The preliminary figures indicate that the shipments of Lake Superior ore by water will exceed 49,000,000 long tons, which, together with the all-rail shipments of more than 800,000 tons, brings the figures for total shipments of Lake ore very close to the tonnage of ore mined and indicates that not much change has occurred in the stocks of ore at the mines in the Lake district. These stocks amounted at the close of 1912 to about 9,500,000 long tons of ore.

In the Birmingham district, Alabama, the production of iron ore in 1913 as indicated by the preliminary returns was about 10% greater than that for 1912. In Tennessee there was apparently a slight decrease and in North Carolina a slight increase. New Jersey and New York both showed slight increases, while Pennsylvania showed a slight decrease. In the Rocky Mountain district of Wyoming, Colorado, and New Mexico there was a slight decrease.

The types of iron ore produced commercially consist of red and specular hematite, brown ore, magnetite, and siderite, or spathic ore. Hematite constitutes about 90% of the output. Only a very small fraction of 1% of the output is siderite, the production of brown ore and magnetite together constituting nearly 10% of the total.

ELECTRIC RAILWAYS IN CANADA.

There are in operation 1,308 miles of electric railways of the first class, main track; second class, main track, 205 miles; siding and turnouts, 121 miles. Total single track, 1,724 miles. The capital involved is $122,841,946, according to a Government report. The revenue collected for the year was $23,400,250, while the working expenses for the year were $14,266,674. The additions made to the capital during the last five years approached $50,000,000.

CENTRIFUGAL PUMPING MACHINERY

ABSTRACT OF INTERESTING PAPER ON THE GENERAL CHARACTERISTICS, POSSIBLE SERVICE, METHODS OF OPERATION AND LIMITATIONS OF CENTRIFUGAL PUMPS, READ BEFORE OTTAWA BRANCH CAN. SOC. C.E., FEB. 12, 1914

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It is not my intention to deal in this paper with the hydraulic design of centrifugal pumps, but rather to endeavor to point out the general characteristics of these machines with reference to the best type of pump to use for a particular duty, to note the services for which these pumps are specially adapted, to give some description of the more general methods of operation, and to describe the limitations of this class of machinery in actual practice.

Characteristics of Centrifugal Pumps.—Centrifugal pumps (and under this heading are included turbine pumps) are regulated by the following general laws:

1. The quantity discharged by a pump, when running at constant speed, varies with the total head against the pump. (By "total head" we mean the head from all causes, including suction lift, delivery head, and head due to friction in the piping.) If the total head be increased (the speed being kept constant) the quantity delivered will be decreased; and conversely, if the head be reduced, a greater quantity of water will be discharged by the pump.

2. The efficiency of a pump running at constant speed varies with the output, and will reach a maximum under a certain condition of head and discharge. A pump which is running at this point is said to be giving normal output. For any given speed, there is a definite maximum possible head which the pump can overcome, and the normal output is nearly always a little below this point.

These general laws have limitations. For instance, the sides of the impeller are revolving in what is generally termed "dead water," and hence if the speed of the impeller is increased, the disc friction is increased until the amount of power absorbed in this manner becomes too large a proportion of the total power absorbed by the pump. When this occurs it is necessary to increase the number of impellers in the pump. One impeller delivers into the next and so on, the head being obtained in a number of stages.

In addition, care must be taken that "cavitation" does not occur. Cavitation may take place either on the suction side or on the delivery side of the impeller. The effect of cavitation is generally overload on the driving machine and unstable delivery by the pump, and in serious cases the pump will stop working altogether. On the suction side, cavitation is caused chiefly by the suction lift being carried beyond the practical limit. On the delivery side, it is most often met with in centrifugal pumps with guide-vanes, (i.e., in that class of pumps generally known as turbine pumps). In these pumps it is generally due to badly designed guide-vanes, or to the pump being used to deliver a quantity of water far in excess of the normal output for which the pump is designed.

Curve No. 1 gives the variation of head and quantity in a pump running at constant speed. This type of curve is generally called the "characteristic curve" of a centrifugal pump, and is the most usually adopted method of showing the performance of a pump graphically. The actual curve shown is one selected at random from a number of test curves, but for convenience we have called the point of normal output 100, so that the quantity delivered, head, efficiency, and brake horse-power for any other point of operation may be read off as a percentage.

Taking, therefore, the normal point of the curve as 100, then at 75% of the normal quantity, the head is 106% of the normal head, the efficiency is 97% of the normal efficiency and the b.h.p. is 84% of the normal b.h.p.

At 75% of the normal head, the quantity is 130% of the normal quantity, the efficiency is 85% of the normal efficiency, and the b.h.p. is 112% of the normal b.h.p.

From this curve, which may be taken as being typical of a well-designed centrifugal pump, it is seen that a good efficiency can be maintained over a wide range. Thus the capacity can be varied from 70% below normal to 120% above normal with a fall of only 5% in the normal efficiency. On looking at the b.h.p. curve, we see that the maximum possible power taken by the pump is only 17% greater than normal. This being so, it follows that a reasonably well-built motor will be capable, running at constant speed, of taking charge of any duty which the pump may be called on to perform at that speed. My firm have frequently built pumps in which there was practically no overload at all, but as a rule all that is necessary is to design the pump so that the maximum overload does not exceed about 10% to 15% or even 20%, as any motor with a good rating will stand this overload without damage.

An important point to notice in connection with centrifugal pumps (and this may also be observed from the curve) is that there is no possibility of damage to the pumps in event of the delivery valve being closed during pumping operations. Thus, on the curve shown, when the valve is closed the pressure is only 92% of the normal.

While the curve shown may be taken as being typical of a well-designed centrifugal pump, it is also possible by suitable modifications in the internal design to alter the features of this curve to suit particular requirements. Thus pumps can be built in which the variation of the quantity with head is large, and others with small variation, but pumps with large variation of quantity are susceptible to a heavier overload than those with small variation. It is not possible to combine maximum quantity variation with minimum overload, but while minimum overload can only be combined with moderate quantity variation, a very fair compromise can be effected in practice. It is often necessary to design pumps with a special characteristic to suit certain specified conditions. Thus, in the case of graving docks, the head generally varies from zero to maximum, while the dock is being pumped out, but by suitable design of the pumps the

power can be kept approximately constant throughout the operation with the motor running at constant speed. The driving motor is thus running economically during the whole period of pumping, and the size and cost of the motor reduced to a minimum.

I have confined myself in these remarks on the characteristics of centrifugal pumps chiefly to the question of constant speed operation, because in Canada most of the electric current supplied is alternating, but a few remarks on the operation of centrifugal pumps at variable speeds may not be amiss.

To illustrate these remarks I have plotted curve No. 2 from actual test results. The first point to notice is that the speed of a centrifugal pump varies as the square root of the head and as the quantity delivered. The curve marked "normal," drawn through the points of maximum efficiency at each speed, is a parabola. Similar curves, the points on which all represent equal efficiencies, can also be drawn.

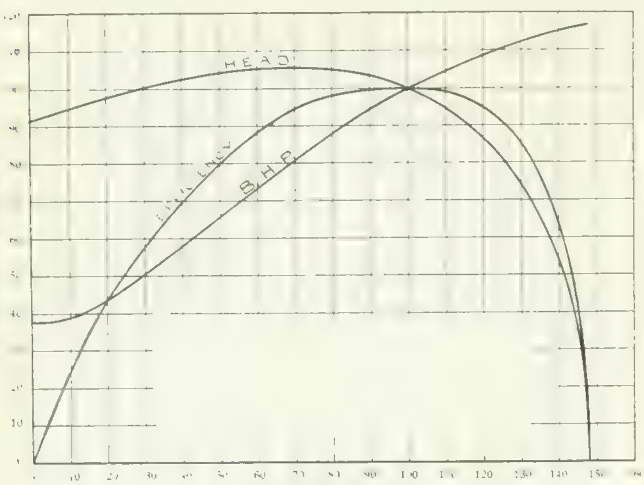

Fig. 1.—Characteristic Curve of Centrifugal Pump at Constant Speed.

Suppose a centrifugal pump is working at the point *G*, i.e., delivering 2,350 gallons per minute against a total head of 37 feet at a speed of 650 r.p.m., the efficiency being 78%. Now, suppose the speed is kept constant and the head is reduced to 30 feet, it will be seen that the quantity is increased to 2,750 gallons per minute and that the efficiency taken on the parabola has dropped to 70%. Now, suppose that instead of keeping the speed constant we reduce it till we get the head required, and we find that in doing so the quantity delivered has become reduced to 2,150 gallons per minute at the point *H*. The efficiency remains the same as it was at *G*. (In cases where the head is very greatly reduced this is qualified by the fact that the blade angles of the impeller are not quite correct for the lower speed.)

Now, suppose we are told that we must have the same quantity of water as before, but with the head reduced to 30 feet. Drawing the constant speed curves through the point *H* (i.e., the point where we had both the head and quantity reduced) and through the point *K* (i.e., the point where the head is reduced and the quantity remains the same as before) we find that we must now increase the speed by an amount, *J K*, or starting from the point *G*, the speed must be reduced by an amount *K L*.

The point *M* was where we got to by reducing the head at constant speed. The point *K* is where we get to by reducing the speed, keeping the quantity constant. It can, therefore, be seen that the most economical way to work under a varying head is to vary the speed, since the point *K* represents a better efficiency than the point *M*. Further, the additional quantity of water obtained at constant speed when the head falls, may not be desired; but if it is, then there is no object in varying the speed; should the additional quantity of water not be required, the balance of head can be made up by partial closing of the sluice valve, but the head taken up in the sluice valve represents that much wasted power.

Range of Application of Centrifugal Pumps.—Centrifugal pumps may be used under almost any conditions where it is necessary to deal with liquid or semi-liquid. There is such a wide range of uses that we will readily recognize that there must necessarily be a considerable variation in design between the various types of pump. Thus, where there is only a small percentage of gritty matter in the liquid to be dealt with, it is only necessary to make certain wearing parts of the pump easily renewable, but when the liquid contains a considerable amount of solid material of an abrasive nature, it is usually necessary to build a pump which is lined either partially or wholly in the interior. There is a good deal of divergence in the design of various makers of dredging pumps, and the designs of dredging pumps by the same maker will also vary according to the nature of the duty to be performed. Sometimes it is only necessary to line the pump at the sides, the volute being unlined, while it is often imperative to fit the whole interior of the pump with liners. There are duties where liners of the best manganese steel become worn through in a few weeks, so that it will be seen how necessary it is for a pump working under these conditions to be totally lined throughout.

Lay-out of Centrifugal Pumps.—An important point to notice in connection with the lay-out of pumping schemes is that hot or gaseous liquids should flow into the pump by gravity. When a pump is working on a suction lift it creates the vacuum necessary to overcome the suction lift. If, therefore, a liquid with temperature approaching the boiling point at atmospheric pressure has the pressure on it reduced on account of the vacuum created by the pump, the liquid will tend to vaporize, and if sufficient vapor gathers the pump will stop working. It should also be noted that the higher a place is above sea level, the less the atmospheric pressure becomes, and consequently the possible suction lift of the pump is reduced in proportion. It should also be noted that the specific gravity of a liquid or mixture does not affect the total head dealt with by a centrifugal pump impeller, but it only affects the power necessary to raise the liquid (and of course the pressure in the pump). Thus a centrifugal pump running at a given speed would raise a liquid having a specific gravity of 1.2 to exactly the same height as it would raise water of unit specific gravity, but the b.h.p. taken would be 1.2 times as great and the pressure in the pump would also be 1.2 times as great.

In connection with these remarks on the lay-out of centrifugal pumps, I am fully aware that some of the matters touched on may seem somewhat elementary to those who are familiar with this class of machinery, but as it has frequently happened that an oversight in what may seem a small and obvious item in the complete design of a pumping plant has been overlooked in the general arrangement, I feel that on this account and for the benefit of those who have not been in touch with this class of work, I am justified in elaborating these matters.

In order to make the suction lift as small as possible, centrifugal pumps should be placed as close to the water as possible. Where there is a suction lift, the pipes should be as short and direct as possible, and should always incline upwards to the pump. If this is not pos-

sible they may be horizontal, but they should never dip downwards as this may allow air pockets to be formed with consequent unsatisfactory working. I have come across cases where air pockets have been unavoidable, and it has been necessary to keep the highest point of the suction pipe in communication with a condenser or vacuum pump. As a rule it is not advisable to exceed a suction life of 20 ft. including friction, but where it is necessary to go beyond this, the suction pipe line should be tested to a pressure of 30 lbs. per inch and should be absolutely tight under this pressure. It should be remembered that the effect of air in a centrifugal pump is to reduce the quantity of water delivered.

Suppose a volume of air, Vo, obtains access to the suction pipe, then at a pressure P this volume becomes

$V = Vo \dfrac{Po}{P}$ where Po is the pressure when volume is Vo. As the orifice in the pump is fixed, then when working at constant speed, if solid water is being dealt with, the volume delivered against a given external resistance has a given value, but if air is also present then the volume is reduced by V (the volume of air at the given point of minimum pressure). It follows, also, that as the characteristic is developed from zero quantity to maximum quantity the vacuum will increase so that the result generally is a reduction in the equivalent orifice due to the greater expansion at higher vacuum and increased air quantity. The effect is shown graphically on curve No. 3 and it can be seen how serious this trouble becomes at the larger quantities. The ultimate result of excessive air leakage is that the water column becomes broken on the suction side and the pump will stop delivering. Where the water flows into the pump under a head, if it is impossible to avoid loops or pockets, it is advisable to place an air cock at the highest point of the pocket to release the accumulated air.

The speed of water in delivery pipes should not exceed about 500 ft. per minute unless the pipe line is very short. It frequently happens that the output of a centrifugal pump with a certain size of delivery or suction branch is much too great for the pipes to be made the same size as the branches. In such cases it is advisable to fit taper pipes next the pump branches. The length to make these taper pipes to give the best results is given by the formula

$$\text{Length} = \frac{D - d}{2 \times 0.12}, \text{ approximately equal to } 4\,(D - d)$$

Where D = diam. of large end in inches

d = diam. of small end in inches

0.12 = constant representing tan $6^\circ\ 50'$.

(This angle of about 7° has been found by experiment to be about the best for water.)

Where centrifugal pumps are working on a suction lift it is necessary to charge them (and the suction pipe) with water. There are two methods of doing this:

(1) To withdraw the air from the pump casing and suction pipe, thus causing a vacuum which becomes filled with water from the suction tank or sump.

(2) To place a foot-valve at the bottom of the suction pipe and fill the pump and suction pipe with water.

As examples of the first method we have the steam ejector, compressed air ejector, and ejector operated by water. Any of these ejectors may be used according to the facilities offered. The ejector is generally placed on the top of the pump casing and when the pump and suction pipe have become filled with water the steam, compressed air, or pressure water is shut off and the centrifugal pump started up. The air in the suction pipe and pump may also be withdrawn by means of a vacuum pump. This is operated by hand or power according to size. In the smaller sizes of centrifugal pump, the air pump is often attached to the pump bedplate but in the larger sizes where power is required it is generally made an independent unit. In the case of intermediate sizes, it is sometimes driven from the centrifugal pump spindle by means of a belt or chain.

In the second method, the foot-valve should be placed sufficiently far below the surface of the water to ensure that "solid" water is obtained under all conditions of pumping. Where pumps are charged by means of a foot-valve there is another point which it is important to notice. Suppose a pump is running and the driving motor stops suddenly, due to the blowing out of a fuse or from some other cause, then if the pump is fitted with a foot-valve the column of water in the delivery pipe drops down and closes the valve. It can be readily understood that in cases where the static head is considerable, the pressure caused by this column of water being suddenly brought to rest may become very great, and as the pump casing is generally weaker than the pipes on account of its larger diameter, there is great danger of the pump being burst and destroyed. It is, therefore, necessary where the static head (including suction) is greater than 30 or 40 feet, to fit a check valve on the delivery side of the pump. It is often handy to fit this valve with a by-pass which can be opened for the purpose of charging the pump.

The design of the foot-valve selected should be such that the flap can be easily raised by the centrifugal pump, as if the flap is too heavy the valve does not come fully open and the pump will not deliver its full quantity. In fact, cases have occurred where the centrifugal pump could not open the valve at all on account of the excessive weight of the flap. Foot-valves should always be chosen so as to give a clear area through them at least equal to the area of the suction pipe. In large sizes foot-valves, where used, are generally of the multiple flap type, though it is usual to employ one of the other methods of charging for large centrifugal pumps. Strainers are nearly always fitted to the suction pipes, and these should always be of large area.

Some Types of Centrifugal Pumps.—Centrifugal pumps may be broadly divided into three different classes, according to the head to be pumped against, and I shall give some illustrations showing variations of these classes.

Class I.—Ordinary centrifugal pumps for heads up to about 150 feet.

Class II.—Twin series centrifugal pumps for heads up to about 300 feet.

Class III.—Turbine pumps, i.e., centrifugal pumps having fixed guide blades in the pump casing and suitable for pumping up to the greatest heads.

In cases where the suction lift would be too great for the pump if placed on the ground level, or where on account of the expense of excavating a larger well, or where on account of risk of flooding it would not be advisable to place the motor down along with the pump, vertical spindle pumps are adopted. Thus, where sewage has to be pumped, the liquid should flow into the pump by gravity, as gas is given off more freely in a partial vacuum, such as occurs in a pump working with a suction lift. In these cases the motor is kept on ground level and the pump spindle is connected to the motor spindle by means of vertical shaft fitted with suitable intermediate

guide bearings. The weight of the motor spindle and armature is taken by the motor thrust bearing, and a common way to support the vertical shaft is by means of a thrust bearing contained in the cast iron steel supporting the motor. A flexible coupling is generally fitted between the motor spindle and the vertical shaft and sometimes also between the vertical shaft and the pump spindle. Where this is done it is necessary for the pump to be provided with a bearing to take the weight of the pump spindle and impeller, but where the lower flexible coupling is discarded and solid coupling fitted, the weight of the rotating parts of the pump is taken by the thrust bearing in the motor stool.

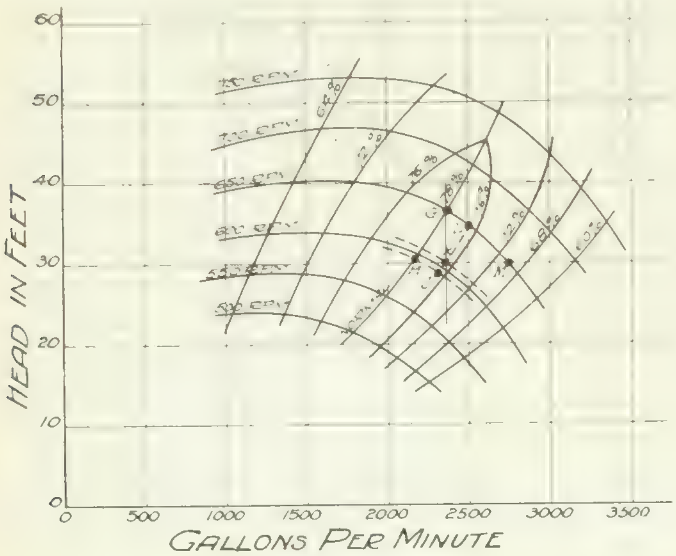

Fig. 2.

In cases where there is a very considerable rise and fall in the level of the suction water, say, greater than 20 to 25 feet, where there is a difficulty in charging the pump, or where for the sake of convenience it is advantageous to do so, the vertical spindle pump may be totally submerged. In such cases the pump is fitted with bearings of lignum vitae which are lubricated by the water, and any of the intermediate bearings which are likely to become submerged are also fitted with lignum vitae and arranged with a water service for use when these bearings are not submerged. With submerged pumps, the lower flexible coupling is done away with.

With all vertical spindle pumps, it is most important that the foundations and floor are rigid so as to prevent any possibility of relative movement between the pump and the motor. It is, of course, essential that the shafting be properly aligned. As my firm have built vertical spindle pumps having shafts up to eighty feet long it can be readily understood that there is a considerable range for pumps of this type.

Then, there is also what is termed a "multi-rotor" pump. One of these pumps recently built had six impellers all on the same shaft. When driven by an exhaust turbine at a speed of 2,500 r.p.m. it delivered 8,000 gallons per minute on a total head of 25 feet. Each of the six impellers passes its share of the water against 25 feet head, the water being split up in this manner to enable a high speed to be obtained on low head with a large quantity of water, thus making the turbine drive practicable. The pump casing is horizontally divided so that the whole of the inside of the pump can be inspected by lifting off the top half. Special diffuser pipes are fitted on the suction and delivery in order to maintain a good hydraulic efficiency.

Twin series pumps consist of two centrifugal pump casings bolted together. The first pump delivers into the second and thus for a given speed double the pressure is obtained from a twin series pump as compared with a single pump. In some cases, it is found more convenient to have a motor between two single pumps, one at each end of the bedplate, and by a suitable arrangement of piping and valves, the pumps can be put either in series or in parallel. This is an excellent arrangement where it is desired to have pumps suitable for either domestic or fire service as required.

The pumping plant supplied for the City of Edmonton, Alberta, is an example of twin series pumps. There are two sets of twin series pumps, each driven by an auto-synchronous motor of 850 b.h.p. at 900 r.p.m. Each pump, when working by itself, gives an output for domestic purposes of 10,000,000 gallons per day (say, 7,000 gallons per minute) against a pressure of 110 lbs., and when the two pumps are put in series, the combined output of the plant for fire purposes is 7,000 gallons per minute against a pressure of 160 lbs. The pump casings are fitted with gunmetal liners to prevent corrosion, the pump covers are fitted with impeller bearing rings, the impellers are of phosphor bronze, and the spindles are of nickel steel fitted with gunmetal sleeves.

In ordinary centrifugal and twin series pumps it is most important that the pump volute should be properly designed in order to reduce the speed of the water after it leaves the impeller in such a manner as to get the greatest efficiency from the pump, and, of course, the impeller has to be designed so as to give the water the correct velocity (including the correct direction) both at entry and at exit. In the case of turbine pumps, the water, when it leaves the impellers, is taken charge of by fixed guide vanes. These guide vanes must not only have the correct angle for the water leaving the impeller, but they must also be of sufficient radial depth to ensure that the proper amount of velocity is converted into pressure head. If the guide ring is too short there will be a loss of efficiency due to the water not being sufficiently slowed down before passing from the vanes. If, on the other hand, the guide ring diameter is made very large, the weight of the pump (and hence the price) becomes excessive, and a compromise has to be struck, the practice varying according to the ideas of the respective manufacturers. Guide vanes are generally made of hard phosphor bronze, or some other similar material to prevent corrosion. When guide vanes become worn, the efficiency of the pump falls and as the vanes introduce an additional element of wear in the pump, where the head is not too great twin series pumps may be used with advantage since they have no guide vanes and can be made with practically as good an efficiency as the turbine pumps.

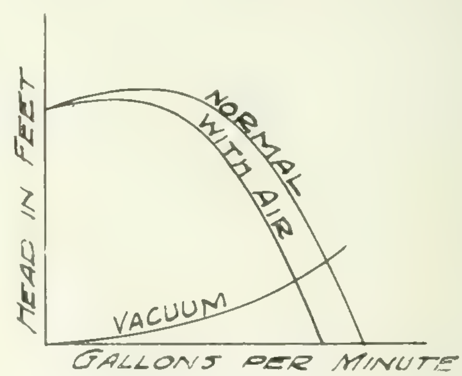

Fig. 3.

The impellers of multi-stage turbine pumps are generally of the single suction type. The most common ways of taking up the end thrust are by an automatic hydraulic balancing device or by a mechanical thrust bearing. Where the water to be pumped is clean, the hydraulic balancing device works very well, but where the water is gritty a good deal of wear takes place, and it is often found advisable to use the mechanical thrust bearing which very often takes the form of double-acting ball thrust bearing on the end of the pump shaft. Most hydraulic thrust bearings are built on the following lines: A disc which may be termed the piston is attached to the pump shaft inside the casing between the impeller of the last stage and the delivery gland, and this piston has a small chamber behind it. On the side nearest the impeller the disc has a working face corresponding to a similar face on a distance piece attached to the pump casing. If the pressure in the last stage is greater than the pressure behind the piston, the faces tend to move apart and the pressures are equalized and vice versa. This automatic regulation, based on difference of pressure, can, of course, be carried out in a number of different ways, and where the water in the pump is clean it has proved very satisfactory.

An example of this type of pump is the installation at Renfrew, near Ottawa. This pump is a 12-inch one, with four impellers, and is driven by a water turbine. The pump casing is sheathed with bronze, impellers and guide vanes are of phosphor bronze, and the spindle is of nickel steel sheathed with gunmetal. Automatic hydraulic balancer is fitted. Flexible coupling is fitted between the pump shaft and the turbine shaft. Some tests taken on this pump a fortnight ago, after about 18 months' operation, show that at the required speed of 590 r.p.m., the quantity delivered is fully 10% in excess of that called for by the specification, and the head pumped against 4 lbs. higher than the guaranteed figure.

Turbine pumps driven by a compound enclosed forced lubrication engine through double helical gearing, contained in gear box, are coming into greater favor. A two-stage pump of this kind, built recently for a head of 400 feet, runs at a speed of 1,200 r.p.m. The engine runs at 400 r.p.m., the gear ratio being 1 to 3. This is interesting, as showing how a suitable pump speed may be obtained from a slow-running steam engine, or from a water turbine where low head limits the speed. Well-made double helical gears contained in gear boxes have shown themselves to be thoroughly reliable, as indicated by the increasing extent to which they are being taken up for marine propulsion, enabling the turbines and propellers respectively to be run at their most economical speeds, and well-designed gears of this type are wonderfully quiet. So far as I can judge, helical gearing for high-speed machinery does not appear to have been adopted extensively in Canada, but I have no doubt that it will find considerable favor in the future on account of its convenience and adaptability where it is difficult to work in direct-coupled pumps, and particularly in cases where, if direct-driven, the low speed of the driving motor would necessitate the supply of a large and costly pump.

The Canada Cement Company announces that, owing to the dullness of business, they have decided to close down four of their plants for the balance of the year 1914, or until further notice. The plants affected are those at Marlbank, Ont., Lakefield, Ont., Shallow Lake, Ont., and Calgary, Alta.

COAST TO COAST.

Guelph, Ont.—Last year's receipts to Guelph from the Guelph Junction Railway earnings, amounted to $42,000. compared with $34,850 in 1912

Stratford, Ont.—The annual statement of the Stratford Light and Heat Commission shows a net surplus for 1913 of $10,218.35 on the account of the civic operating plant.

Galt, Ont.—In January, the Galt hydro-electric department made 88 new installations of service. The total number of hydro power consumers in that municipality is now considerably over 1,600.

Stratford, Ont.—The report of the Perth county engineer, Mr. John Roger, for the year 1913 shows an expenditure of $25,592.63 spent in road construction, including draining; on bridges, $5,744.02; for machinery, $3,135.77; for county road superintendent and foreman, $2,133.35, making a total of $36,585.77.

Prince Rupert, B.C.—The floating drydock for the G.T.P. Railway and Steamship Company, upon which construction is commencing at Prince Rupert at a cost of $3,000,000, will have a lifting capacity of 20,000 tons, according to the plan furnished by William T. Donnelly. These also show a structure so designed that it is capable of operating in sections as a number of smaller docks.

Berlin, Ont.—The two electric pumps for the Berlin waterworks system have been installed, and are giving satisfactory service. They have a capacity of 800 gallons per minute, or 1,152,000 gallons per day, and are designed to pump against a head of 200 pounds. The pumps were manufactured in Zurich, Switzerland; and are connected with a gasoline engine to be used in case of emergency.

Vancouver, B.C.—Up to the end of 1913 the expenditure by the Greater Vancouver Joint Sewerage Commission amounted to $48,374.04, according to the statement issued by Mr. Frank Bowser, chairman of the board. It is expected that the expenditure this year will exceed a quarter of a million dollars. Also, steps are being taken to change the name of the board to the Vancouver and District Joint Drainage Board.

Victoria, B.C.—The auditor-general's report for the first six months of the current fiscal year, April 1 to September 30, was presented to the Provincial Legislature on January 22nd. The total expenditure for these months was $10,020,-102.10, and included the following as some of its items:—Works and buildings, $1,292,680.28; roads, streets, bridges, and wharves, $3,115,787.19; subsidies to steamboats, ferries, and bridges, $32,077.15.

Ottawa, Ont.—A return tabled in the Dominion House of Parliament on January 28, giving the 7th report of the Commissioners for the demarcation of the 171st Meridian, west longitude, stated that the field work in connection with the whole survey in the Yukon is practically finished. 202 monuments mark the line from the Arctic Ocean to Mount St. Elias, a distance of 645 miles, and a vista 20 feet wide has been opened through all the timber.

Montreal, Que.—The annual report of the Ottawa Electric Railway Company for the year ended December 31, 1913, shows gross earnings of $1,041,282, an increase of $106,885, and net earnings of $412,160, an increase of $12,101. During the year, a large amount has been spent in improving tracks and rolling stock as well as other properties. Four short track extensions were laid, and two sub-power stations built. The record of the company shows an increase in gross receipts from [illegible]

Winnipeg, Man.—The second annual report of the Manitoba Public Utilities Commission shows that in the fiscal year ending November 30, 1913, the commission dealt with 43 formal applications, which devolved into 63 proceedings and orders, covering almost every phase of railway, water, light and power activities and the distribution thereof, and also covering corporate rights and financing such as transfers, increase and issue of stocks. There were also 34 separate proceedings and orders instituted upon the commission's own initiative.

Swift Current, Sask.—With the completion of Swift Current's storage dam, it is believed that the town's water supply should be assured for years to come. At least 80,000,000 gallons are now conserved for city purposes, and in addition a liberal supply is reserved for the use of the C.P.R. amounting to 3,500,000 gallons daily. The supply is obtained from the Swift Current Creek, which rises in the Cypress Hills to the south, and according to Government chemists is of unsurpassed purity and of a degree of softness that makes it especially suitable for manufacturing purposes.

Chilliwack, B.C.—The new concrete sluice has been installed and is in operating order at the Chilliwack pumping plant. Considerable trouble, due to quicksands, was experienced by the contractors for the work, Love Bros. & Shirley; but the difficulty was met by the driving of piles on both sides of the Semiault river, both above and below the gates. The bed of the river below the gates is also to be lowered and widened to the depth of the bottom of the Chilliwack river. This will minimize the danger of the bed of the Semiault filling up and rendering useless the automatic gates.

Ottawa, Ont.—The main estimates of expenditures by the Dominion Government for the coming fiscal year call for a total vote of $190,735,176. When the supplementary estimates have been added to this amount, it is expected that the total will exceed considerably the total estimates of last year, $202,656,166, of which the main estimates amounted to $179,152,183. In main estimates, this year shows an increase of $11,582,993. And it is expected that, with appropriations by special statute to be added, the grand total of expenditures authorized by Parliament will reach the quarter-million mark.

Saanich, B.C.—The report of the engineering department of Saanich has been presented by Municipal Engineer Topp to the Saanich council. It shows surveys and estimates in various branches of public works making a total since March, 1913, of $507,900; while the total cost of the engineering department for the 10 months was $4,193.22, or less than 1 per cent. of the total estimates furnished. Of the various items comprising the amount for estimates, the cost of grading a number of roads totalled $131,095; the cost furnished on plans for water supply in the districts close to Saanich, totalled $77,522; and the cost for drainage schemes, $5,010.

Victoria, B.C.—The public accounts of the province of British Columbia for the fiscal year ending March 31st, 1913, were placed before the legislature on January 15th. From these it is seen that the net revenue of the province for the year was $12,510,215.08, and the net expenditure $15,412,322.02, making a balance of expenditure over revenue of $2,902,106.94. The revenue for the previous fiscal year ending March 31st, 1912, was $10,745,708.82, and the expenditure $11,189,024.35. In the way of expenditure in 1913, among the largest items are: roads, streets, bridges and wharves, $4,790,461.24; works and buildings, $2,815,648.50.

Montreal, Que.—Montreal's 1914 programme of civic development provides for the laying of about 20 miles of permanent pavements, on central streets, and a large amount of macadamizing on suburban streets, at an estimated expenditure of about $1,500,000. The paving law which charged the cost of paving on the proprietors having been repealed, the city will have to take this amount out of the loan fund, unless new legislation is made by the council in the form of a local improvement tax or some other method of financing the work. Besides permanent pavements, the programme provides for an expenditure of $1,091,000 for sidewalks, $1,700,000 for sewers and $760,000 for the aqueduct.

London, Ont.—A surplus of $36,111.14 has been reported for London's electrical department for 1913. However, Chief Engineer Gaby of the Ontario Power Commission claims that 5 per cent. of the capitalization ($439,362.49), or $21,716.32, should be deducted from this surplus for depreciation. Also, equipment consisting of switchboards, converters, transformers and other machinery, costing in the neighborhood of $30,000, is now under order by the department for the purpose of supplying the London Street Railway Company with Niagara energy. When this amount is taken out of the capital account it would appear that the department will show a deficit of some $15,000 instead of the surplus announced.

Sinclair, B.C.—There is under construction between Sinclair and Castle Mountain in British Columbia a link of 60 miles of the great circular highway which forms one of the most important features in the programme of trunk roads for that province and will afford one of the finest scenic highways for motorists on the continent. The completion of the undertaking, for which the Canadian Pacific Railway have undertaken to pay half the cost, will mean more than 500 miles of good roads always within view of the Rockies, running through Cranbrook and the Crow's Nest Pass to Calgary, thence continuing westward over the driveway to Banff recently constructed by the Dominion Government.

Kingston, Ont.—The city of Kingston has in immediate consideration an additional water main capacity. The point of difference lies in the territory to be covered. Two sections have been proposed; one scheme being to replace the old 6-inch pipe on Union Street and to obliterate the dead ends on Clergy Street, opening up a circuit of $3.225 feet of 18-inch cast-iron pipe at an approximate expenditure of $23,638.56; the other also proposing to replace the pipe on Union Street, but coupling up the dead ends on West and Bagot Streets, and replacing the uncoated Kingston foundry pipe, now installed on Union Street, representing a total distance of 5,725 feet and an approximate expenditure of $43,936.30.

Edmonton, Alta.—There were recently in Edmonton, after inspecting the country traversed by the new G.T.P. line, and particularly the section surrounding Willow River, Mr. St. John, manager of the Transcontinental Townsite Company, Mr. George Hartford of the Morning Inter-Ocean, Chicago, and Mr. W. P. Hinton, general passenger agent of the G.T.P. Company. They estimated that on the Willow River there is enough potential electric energy to supply several cities of hundreds of thousands of population each, while 12 miles away from the town are vast beds of coal of good quality, as well as other minerals. On the Willow River alone there is at least 9,000,000 feet of timber, according to Government estimates, of size and quality equalled, only by the giant trees of the coast.

Toronto, Ont.—The concrete work on the bridge being constructed over the Walmer Road Hill ravine on St. Clair Avenue West, is now complete. Mr. E. C. Law, the contractor for this portion of the work states that in the foundation over 800 white oak piles have been used, averaging a length of 45 feet each; that about 6,000 cubic yards of concrete were necessary for the monolithic piers; and that the total weight of material used in this part of the construction was about 10,000 tons. The structure consists of two abutments and 8 piers, in sections of 4 each, arched together at the top. The central span, running north and south, measures 100 feet clear between piers, while on either side is a span of 40 feet. McGregor and McIntyre, the contractors for the steel

work, are now busily engaged in placing the smaller girders in position. This work will be continued without interruption to completion.

Regina, Sask.—Steps are being taken here with the view to mining coal at Grand Coulee. Tests have been made as to the usefulness of this coal, and the scientific test by Dr. W. W. Andrews gave 10,800 British thermal units per pound of dry coal. It is believed that the deposits of coal in this vicinity are of considerable extent; and trial tests to discover the probable quantity are being made. At the point where the well was sunk, coal strata was 6 feet thick, and of increasing thickness on the north side. If the deposit is of sufficient extent to warrant mining operations the close proximity of this field to Regina will make it a valuable asset. Recently, a second seam of coal has been struck at Grand Coulee. The thickness of this seam has not yet been tested, but it is claimed that the coal is harder and of better quality than the first find. Its discovery has greatly increased the interest in Grand Coulee coal, and further drilling operations will be carried on with a view to discovering the possibilities of this second field.

Victoria, B.C.—The report of the Inner Harbor Association upon the work completed last year gives the following information:—"In the upper harbor, or basin, a large portion of the bottom has now been dredged to 20 feet deep at low water, with berths at the Canadian Puget Sound Mills of 25 feet. The large rock, about the middle of the basin, will shortly be removed. The lower harbor generally, where dredging can be done, is now 20 feet deep at low water. The rock on the western side of the entrance (off Behren's Island) has been removed; and the rocks off Shoal Point on the eastern side of the channel, have been cut back, thus widening the channel by about 60 feet and, to some extent, straightening out a very difficult turn. To the southeast of Songhees Point, the rocks have been cut back to 16 and 20 feet deep at low water. It is proposed to remove the remainder of the triangle to the railway bridge by contract work and the material utilized for reclamation purposes as originally proposed. The total amount of rock, clay, gravel and sand removed in the harbor has been about 550,000 cubic yards."

Vancouver Island, B.C.—The construction of the initial portion of the substructure of the breakwater at Ogden Point has progressed as far as is possible until more favorable weather conditions will permit of the divers laying the huge granite blocks that will form the base of the concrete structure. In the meantime, the contractors, Sir John Jackson, Limited, are concentrating their efforts upon the first 1,000 feet of the breakwater. Upon the site of this construction, in practically three weeks of the month of December, there were dumped 22,744 tons of rubble. In addition, at the core, there were dumped 9,715 tons. On the first 900 feet the stone has been levelled up to a depth of approximately 20 feet from low water mark; and arrangements have been made by Sir John Jackson, Limited, to have the first shipment of granite blocks brought down from Nelson Island early next month. This granite has been tested at the Government Laboratory and is declared to be of the most excellent quality obtainable anywhere on the coast. All the cement to be used in the construction work on the breakwater will be supplied by the Associated Cement Company, a Canadian firm, and samples of this material have been tested and approved by Government specialists for this kind of work in Canada. Also on the land side at Ogden Point, progress is shown. Already 6,394 cubic yards of rock have been excavated on the site where the giant sea-wall will extend its tentacles of stone seaward. A large area has been levelled off and several miles of steel track have been laid for the operation of the steam-engines hauling the dump-cars to the various parts of the site.

CONCRETE ROAD BUILDING CONVENTION—PROGRAMME.

The following is the programme of the National Conference on Concrete Road Building, which is being held on Thursday, Friday and Saturday of this week at the Auditorium Hotel, Chicago. Professor W. F. M. Goss, dean of the University of Illinois, School of Engineering, is chairman.

Thursday afternoon session, W. F. M. Goss presiding.

Address—"The National Conference on Concrete Road Building." W. F. M. Goss, dean, College of Engineering, University of Illinois, Urbana, Ill.

Address—"Financing Permanent Roads." S. E. Bradt, secretary, Illinois State Highway Commission, Springfield, Ill.

Address—"Can a Rural Community Afford Permanent Roads?" Oliver Dunlap, president, Iowa State Supervisors' Association, chairman, Board of Supervisors, Washington County, Iowa.

Address—"The Concrete Road System of Wayne County, Michigan." Edward N. Hines, chairman Board of County Road Commissioners, Wayne County, Michigan.

Friday morning session, A. N. Johnson presiding.

Address—"Development of Concrete Roads in the United States." Henry C. Shirley, chief engineer, Maryland State Roads Commission, Baltimore, Md.

Reports of committees:—

I.—"Contraction and Expansion of Concrete Roads." Chairman, R. J. Wig, Bureau of Standards, Department of Commerce, Washington, D.C.; N. H. Tunnicliff, civil engineer, Davenport, Iowa; W. A. McIntyre, engineer, Association of American Portland Cement Manufacturers, Philadelphia, Pa.

II.—"Joints for Concrete Roads." Chairman, W. K. Hatt, professor in charge, School of Civil Engineering, Purdue University, Lafayette, Ind.; George W. Cooley, state engineer, St. Paul, Minn.; R. J. Wig, Bureau of Standards, Department of Commerce, Washington, D.C.

III.—"Methods and Cost of Repairing and Maintaining Concrete Roads." Chairman, Edward N. Hines, chairman, Board of County Road Commissioners, Wayne County, Detroit, Mich.; J. S. McCullough, city engineer, Fond du Lac, Wis.; F. P. Wilson, city engineer, Mason City, Iowa.

IV.—"Preparation and Treatment of Sub-Grade for Concrete Roads." Chairman, Ira O. Baker, professor of civil engineering, University of Illinois, Urbana, Ill.; A. R. Hirst, state highway engineer, Madison, Wis.; A. N. Johnson, state highway engineer, Springfield, Ill.

V.—"Reinforcement of Concrete Roads." Chairman, Thomas H. McDonald, state highway engineer, Ames, Iowa; Henry E. Riggs, professor of civil engineering, University of Michigan, Ann Arbor, Mich.; Richard L. Humphrey, president, American Concrete Institute, Philadelphia, Pa.

Friday afternoon session Ira O. Baker presiding.

Address—"Experiments with Concrete for Roads Conducted by the United States Office of Public Works." Logan Waller Page, director, United States Office of Public Roads, Washington, D.C.

Reports of committees:—

VI.—"Aggregates for Concrete Roads." Chairman, Sanford E. Thompson, consulting engineer, Newton Highlands, Mass.; A. N. Talbot, president, American Society for Testing Materials, Urbana, Ill.; W. M. Kinney, assistant engineer, Universal Portland Cement Company, Pittsburg, Pa.

VII.—"Shoulders for Concrete Roads." Chairman, Maj. W. W. Crosby, Baltimore, Md.; C. A. Kingsley, state highway engineer, Little Rock, Ark.; John H. Mullen, secretary, Minnesota Roadmakers' Association, St. Paul, Minn.

VIII.—"Bituminous Surfaces for Concrete Roads." Chairman, E. J. Mehren, editor-in-chief, Engineering Record, New York City, Henry G. Shirley, chief engineer, State Roads Commission, Baltimore, Md.; James R. Marker, state highway commissioner, Columbus, Ohio.

IX.—"Finishing and Curing Concrete Road Surfaces." Chairman, F. E. Turneaure, dean, College of Engineering, University of Wisconsin, Madison, Wis.; H. J. Kuelling, president, Wisconsin Highway Commissioners' Association, Milwaukee, Wis.; E. D. Boyer, engineer, the Atlas Portland Cement Company, New York City.

X.—"Economic Methods of Handling and Hauling Materials for Concrete Roads." Chairman, Halbert P. Gillette, editor-in-chief, Engineering and Contracting, Chicago; Donald D. Price, state engineer, Lincoln, Neb.; Percy H. Wilson, secretary, Association of American Portland Cement Manufacturers, Philadelphia, Pa.

Saturday morning session W. F. M. Goss presiding.

Address—"Concrete Road Construction by the Ohio State Highway Department." James R. Marker, state highway commissioner, Columbus, Ohio.

Reports of committees:—

XI.—"Mixing and Placing Materials for Concrete Roads." Chairman, Paul D. Sargent, chief engineer, State Highway Commission, Augusta, Maine; Arthur H. Blanchard, professor of highway engineering, Columbia University, New York City; C. W. Boynton, inspecting engineer, Universal Portland Cement Company, Chicago.

XII.—"Cost of Constructing Concrete Roads." Chairman, A. N. Johnson, state highway engineer, Springfield, Ill.; Joseph Hyde Pratt, state engineer, Chapel Hill, N.C.; Albert Reichmann, president, Western Society of Engineers, Chicago.

XIII.—"Thickness, Crown and Grades for Concrete Roads." Chairman, Leonard C. Smith, in charge of roads and pavements, University of Wisconsin, Madison, Wis.; Earle R. Whitmore, city engineer, Port Huron, Mich.; T. R. Agg, assistant professor in civil engineering, Iowa State College, Ames, Iowa.

XIV.—"Proportion and Consistency of Materials for Concrete Roads." Chairman, C. U. Bowley, city engineer, Sheboygan, Wis.; C. C. Widener, city engineer, Bozeman, Mont.; George A. Dingman, engineer, Board of County Road Commissioners, Wayne County, Detroit, Mich.

XV.—"Form of Specifications for Concrete Roads." Chairman, A. Marston, dean and director, Division of Engineering, Iowa State College, Ames, Iowa; A. N. Talbot, president, American Society for Testing Materials, Urbana, Ill.; George W. Cooley, state engineer, St. Paul, Minn.

PERSONAL.

A. J. MacLEAN, formerly one of the commissioners of Edmonton, was appointed Assistant City Engineer of that city and assumed his duties on February 2nd.

D. W. JOHNSON has been appointed engineer for the municipality of Saanich, B.C. For the past five years he has acted in a similar capacity at Point Grey, B.C.

J. M. BEGG, assistant city engineer, in charge of sewers, read a paper before the Edmonton Engineering Society on the 5th inst., entitled "The Tunnel Sewers of Edmonton."

J. W. W. DRYSDALE, Jr., B.Sc., director of Drysdale and Co., Limited, of Yoker, Glasgow, Scotland, manufacturers of centrifugal pumps, is in Canada on a four weeks' business trip.

W. A. McLEAN, Provincial Engineer of Highways for Ontario, and a member of the Public Roads and Highways Commission, has been elected president of the American Road Builders' Association.

J. V. MIMMO, division engineer, C.P.R., between Boston Bar and Lytton, B.C., read a paper before the Vancouver branch of the Canadian Society of Civil Engineers, on February 3rd, on railway construction work in British Columbia.

T. H. KETTLE, until recently in the employ of the Toronto Power Company, as manager of the Transportation Department, left for Minneapolis on February 1st to take a position as Assistant Sales Manager for the Minneapolis General Electric Company.

R. G. G. OMMANNEY, a member of the engineering staff of the Canadian Pacific Railway, has recently been appointed engineer to Sir Thos. Shaughnessy, president of the road. Under this new appointment Mr. Ommanney will devote his time to special work.

A. J. McPHERSON, for several years chairman of the Highway Commission of Saskatchewan, has been appointed to the chairmanship of the Government Finance Commission of that province. Mr. McPherson graduated in 1893 from the School of Practical Science, Toronto. F. J. ROBINSON of Regina, formerly Deputy Minister of Public Works, succeeds him as chairman of the Highway Commission.

W. E. WOODHOUSE has been appointed Superintendent of Motive Power for the eastern division of the Canadian Pacific Railway, his headquarters to be in Montreal. Mr. Woodhouse has been in the employ of the company for 22 years, spending a greater portion of that time in British Columbia, coming back to Winnipeg in 1906, where for the past four years he has been Assistant Superintendent of Motive Power of the western lines.

CANADIAN GOVERNMENT EXHIBIT AT SAN FRANCISCO IN 1915.

The final plans for the Canadian pavilion at the Panama-Pacific International Exposition, to be held in San Francisco in 1915, were accepted January 21, and the process of actual construction has begun, under the supervision of Colonel William Hutchison, of Ottawa, the Canadian Exhibition Commissioner. Colonel Hutchison arrived in San Francisco January 14 to inaugurate the work upon the building, preparatory to the arrival of the Canadian exhibit, part of which is now en route. He was joined here by George Freeman, the London architect, who is designer of the building, and his staff.

The pavilion, which will cost approximately $300,000 will be the largest exposition building ever erected by the Canadian Government. It will be 340 feet long, 240 feet wide and 50 feet high. The whole sum expended upon the building and its contents will amount to $600,000 or more.

"THE ST. LAWRENCE RIVER BRIDGE."

At the regular monthly meeting of the Canadian Society of Civil Engineers held in Montreal on Thursday, February 5th, a paper was read on the St. Lawrence River Bridge by Mr. P. B. Motley, M.Can.Soc.C.E., Engineer of Bridges for the C.P.R. Mr. Motley presented some interesting details concerning the method in which the old C.P.R. bridge over the St. Lawrence River at Lachine, P.Q., erected as a single track structure in 1885, has, in the last two years, practically undergone complete reconstruction as a double track without interference to traffic during operations.

The plan adopted was to build two independent single track bridges, removing the old bridge in sections, and transferring the traffic from side to side during the operations.

While this was being done an average of 18 trains a day passed over the bridge during working hours.

The work was accomplished by cantilevering spans from the piers supporting the old bridge, by the sinking of pneumatic caissons under the direction of the Foundation Company, by employing floating barges, and transferring traffic from the old to the new spans as the latter were completed.

CALGARY BRANCH CAN. SOC. C.E.

Some very interesting meetings have been held by the Calgary branch Canadian Society of Civil Engineers since its inception last summer. These meetings usually take the form of a 6 o'clock dinner with an address and discussion following. Mr. J. S. Dennis, M.Can.Soc.C.E., assistant to the president of the Canadian Pacific Railway Co., gave an interesting address to the meeting held on December 29th. His subject was "Early Surveys and Surveyors of Western Canada." Upon a similar event on January 9th, Mr. Geo. W. Craig, M.Am.Soc.C.E., city engineer of Calgary, read a paper on "Modern Pavements." On January 23rd, Mr. Sam. G. Porter, B.A., B.S., M.Am.Soc.C.E., irrigation inspecting engineer for the Dominion Government, read the paper "The Civil Engineer and his Relation to Society," which appears elsewhere in this issue. On February 6th, Mr. H. A. Moore, M.Can.Soc.C.E., and general manager of the Calgary Power Co., addressed the meeting, describing the company's new power plant at Kananaskis Falls on Bow River.

"Irrigation Engineering" is the subject of an address to be delivered at the February 20th meeting by Mr. W. D. Hays, M.Am.Soc.C.E., chief engineer of the Southern Alberta Land Co. at Medicine Hat. At later dates, not as yet definitely decided upon, the speakers will be Mr. F. H. Peters, A.M.Can.Soc.C.E., Commissioner of Irrigation for the Dominion Government; Mr. H. B. Muckleston, M.Can.Soc.C.E., assistant chief engineer, Department of Natural Resources Canadian Pacific Railway; and Mr. H. J. Duffield, B.E., M.I.C.E.

These dinners are held fortnightly and are being largely attended by the members of the Canadian Society resident in Calgary and vicinity. Mr. P. M. Sauder, P.O. Drawer "V," Calgary, is secretary-treasurer of the branch.

TORONTO BRANCH CAN. SOC. C.E.

The local branch of the Canadian Society of Civil Engineers held a luncheon on Wednesday, February 11th, at which a good representation of the members were present. A short address was given by Prof. C. R. Young, Department of Structural Engineering, University of Toronto, who spoke concerning the library which the Society possesses, making a number of apt suggestions respecting its enlargement and concerning ways in which it might be made of more service to the members. In addition to its monthly meetings the branch contemplates holding a monthly luncheon of this nature during February, March and April. The secretary is John S. Galbraith, 57 Prince Arthur Avenue, Toronto.

CHICAGO CEMENT SHOW.

The Seventh Chicago Cement Show begins on February 12th and will continue to February 21st. During this period the following organizations are also convening in Chicago:—American Concrete Institute, National Builders' Supply Association, Interstate Cement Tile Manufacturers' Association, Illinois Lumber and Builders' Supply Dealers' Association, Illinois Association of Municipal Contractors, National Conference on Concrete Road Building.

CANADIAN MINING INSTITUTE.

Among the papers that have already been arranged for in the programme of the annual meeting to be held in Montreal next month, are the following:—

"Mill and Metallurgical Practice at the Nipissing Mining Co., Cobalt, Ont.," by James Johnston, Cobalt, Ont.; "The Sampling of Cobalt Ores," by C. St. G. Campbell, Cobalt, Ont.; "The Veins of Cobalt District," by Arthur A. Cole, Cobalt, Ont.; "Recent Improvements in Cyanidation," by Herbert A. Megraw, New York; "Some Notes on Mining and Milling Practice at the Alaska Treadwell Mine," by H. C. Meek, South Porcupine, Ont.; "Ore Dressing Improvements," by Robert H. Richards, Boston, Mass.; "Recent Metallurgical Developments," by A. Stansfield, Montreal; "Methods of Excavation in the Mount Royal Tunnel," by S. P. Brown, Montreal; "Factors Influencing the Cost of Power for Mining Purposes," by J. M. Forbes, Montreal; "High Carbon Steel for Sluice Linings in Hydraulic Mining," by Howard W. Dubois, Philadelphia; "Mining in British Columbia" (illustrated by colored lantern slides), by Howard W Dubois, Philadelphia; "Scientific Management," by F. B. Gilbreth, New York; "Efficiency Engineering Applied to Mining, Quarries and Industrial Plants," by H. M. Payne, New York; "The Chisana Gold Field," by D. D. Cairnes, Ottawa; "Coal Resources of the World," by D. B. Dowling, Ottawa; "Asbestos Resources of the Thetford Area," by W. J. Woolsey. Thetford Mines, Quebec; "Safety in Coal Mines" (illustrated by moving pictures), by a representative of the H. C. Frick Coke Co., Pittsburgh.

EDUCATIONAL INVESTIGATION OF INDUSTRIAL METHODS.

A number of students taking the Chemical Engineering course at the University of Toronto, under the direction of Professors Bain and Ardagh and Mr. Rogers of the Faculty of Applied Science and Engineering, spent a week on a tour of investigation to points in Western Ontario. The party visited the plants of the Dominion Sugar Co., the Empire Refining Co., and the Canadian Glass Co., afterwards proceeding to Windsor where the works of the Canadian Felt Co. were visited. The new electrolytic alkali plant of this company at Sandwich was also inspected. The party included men of the second, third and fourth years.

COMING MEETINGS.

AMERICAN CONCRETE INSTITUTE.—Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.—Meeting will be held in Chicago, Ill., February 12th to 14th, 1914. Secretary, J. P. Beck, 72 W. Adams Street, Chicago, Ill.

CANADIAN MINING INSTITUTE.—Sixteenth Annual Meeting to be held at Windsor Hotel, Montreal, March 4, 5 and 6th, 1914. Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

AMERICAN WATER WORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914, Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21250—January 26—Authorizing C.P.R. to construct sidings for Fraser, Limited, mileage 20.03, Atlantic Div. Fredericton Sub. Div., at Victoria, New Brunswick.

21251—January 23—Refusing application Corporation Village of Princeville, Que., for Order directing G.T.R. to provide and construct highway over its tracks, about 1050 ft. west of Princeville station.

21252—January 26—Authorizing C.P.R. and Algoma Central and Hudson Bay Ry. Cos. to operate trains over crossing at Hobon, Dist. Algoma, Ont., without their being brought to a stop.

21253—January 24—Relieving C.P.R. from speed limitation of 12 miles an hour on portion of Swift Current Southeasterly Branch Line, from Neville to Vanguard, mileage 27.5 to 43.6.

21254—January 26—Authorizing C.P.R. to construct Two (2) bridges, namely,—mileage 59.8, Kootenay Central Ry., over Findlay Creek, B.C., and mileage 46.62, Kootenay Central Ry., over Skookumchuck Creek, B.C.

21255—January 24—Authorizing, temporarily, City of Toronto, Ont., to operate Danforth Ave. Car Line over G.T.R. Toronto Type Foundry Spur, until June 1st, 1914, pending installation of half-interlocking plant at said crossing.

21256—January 24—Authorizing C.P.R. to construct bridge over Dutch Creek at mileage 75.6 of Kootenay Central Ry., British Columbia.

21257—January 27—Authorizing G.T.R. to construct extension of siding into premises of S. L. Lambert, on Block Y, east side of Burger Street, town of Welland, Ont.

21258—January 24—Extending, until May 1st, 1914, time within which G.T.R. is required to install gates to cover all tracks and sidings as well as main tracks at crossing of the first highway east of Clarkson Station, Ontario.

21259—January 28—Granting leave, temporarily and until further Order of the Board, to city of Montreal, Que., to construct and lay steel water pipe beneath main track and siding of C.P.R. Co.'s Lachine Canal South Bank Branch, subject to certain conditions.

21260—January 28—Authorizing city of Montreal, temporarily and until further Order of Board, to construct and lay 8 feet diameter steel water pipe beneath, along and across right of way of G.T.R. on part Lot 3410, Cadastral plan of Municipality of parish of Montreal, subject to certain conditions.

21261—January 22—Extending, until June 1st, 1914, time within which Cumberland Ry. and Coal Co. equip cars with automatic couplers and air breaks.

21262—January 28—Granting leave to Ottawa Electric Co. to erect, place and maintain wires across track of C.P.R., on road north of Hurdman's Bridge, at mileage 6.64 from Sussex Street Station, Ontario.

21263—January 28—Extending, until May 31st, 1914, time within which C.P.R. complete siding for McCormick Manufacturing Co., Limited, London, Ont., authorized under Order No. 20710.

21264—January 28—Approving plan "A," numbered 52969, showing bridge No. 94.4 on Toronto Subdivision of C.P.R.

21265—January 29—Authorizing the C.L.O. and W. Ry. to construct its line of railway at grade across Front Street, in the city of Belleville, Ont.

21266—January 24—Approving revised location of C.N.O.R. at Grand Lake, Tp. Barron, Dist. of Nipissing, Ont., mileage 126.37 to mileage 129.94 from Ottawa.

21267—January 28—Relieving for the present, the C.P.R. from providing further protection at the crossing of the first highway east of Shebo Station between Secs. 9 and 10, W. 3 M., Sask., at mileage 67.9 on said railway.

21268—January 28—Authorizing the N. St. Catharines and Toronto Ry. Co. and the G.T.R. to operate their cars and trains over Welland Avenue, St. Catharines, Ont., without their first being brought to a stop.

21269—January 28—Postponing the effective dates of the Special Commodity Tariff, C.R.C., No. 217, and the Joint Freight Tariff, C.R.C. No. 221, of the Temiscouata Ry. Co. increasing the rates on pulpwood in carloads and published to become effective on the 1st and 24th days of January, 1914, respectively, until the 15th day of August, 1914; and rescinding Order No. 21105, dated December 23rd, 1913.

21270—January 30—Authorizing the city of Brantford to excavate a new channel across the island immediately below the Homedale District where the L.E. and N. Ry. has built its embankment across old channel.

General Order No. 119—January 31—Ordering that whenever a railway company subject to jurisdiction of Board, intends to remove a regular station agent, it shall first notify the local municipality or Board of Trade of its intention to apply to the Board for and Order permitting such removal.

21271—January 29—Authorizing the C.N.R. to construct its line of railway across and divert public road between Secs. 5 and 6, Tp. 41, Rge. 18, W. 4 M.

21272—January 29—Relieving the Que., Montreal and Southern Ry. from maintaining, for the present, a watchman at the Chemin de Lac Crossing, in the village of Bucherville, Que.

21273—January 29—Rescinding Order No. 21155, which required the C.P.R. to stop its train No. 33 at Claremont on flag for a period of three months from date of Order, December 31, 1913.

21274—January 24—Authorizing the G.T.P. to construct its main line of railway across the Government road at mileages 213 and 214, Cariboo District, B.C.

21275—January 30—Authorizing the G.T.P. Branch Lines Co. and the C.P.R. to operate their trains over the crossing of the C.P.R. Co.'s Moose-Jaw-Lacombe Branch at Druid, Sec. 6, Tp. 33, Rge. 20, W.3 M., without first bringing trains to a stop.

21276—January 29—Amending Order No. 20937, December 1st, 1913, by striking out the figures "10" after the word "Block" where they occur in the recital and operative parts of the Order, and substituting therefore the figures "16."

21277—January 28—Approving revised location of G.T.P. Railway from the east boundary of the N.E. ¼ of Sec. 25, Tp. 53, Rge. 17, to the east boundary of the E.E ¼ of Sec. 22, Tp. 53, Rge. 17, W. 5 M., Alta., from mileage 3.14 to mileage 5.88.

21278—January 28—Authorizing the C.P.R. to construct, maintain and operate branch line of railway or spur for the Boyd Pressed Brick Syndicate from a point on C.P.R. main line, Ont. Div., London Subdivision, at mileage 34.5, in Lot 3, Con. 7, Tp. Nassagawaya, Ont.

21279—January 29—Authorizing the C.P.R. to open for the carriage of traffic portion of its double track from Islington to Guelph Junction, mileage 9.98 to mileage 39.86, Ont.

21280—January 29—Authorizing the C.P.R. to change the grade of its main line of railway, Ont. Div., Havelock Subdivision, across road allowance between Lots 20 and 21, Con. 3, Tp. Bathurst, Co. Lanark, Ont., and to change the grade of present grade crossing at mileage 15.44 on said main line.

21281—January 30—Approving plan No. 55085-2, dated November 27th, 1913, showing proposed crossings over tracks of G.T.R. adjoining Front Street, Toronto, Ont.

21282—January 29—Authorizing the C.P.R. to construct, maintain and operate branch line of railway or spur for the Canmore Coal Company, Limited, Canmore, Alta., from a point on existing spur in the S.E. ¼ Sec. 29, Tp. 2, Rge. 10, W. 4 M., at Canmore, Alta.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

MODERN CRANE EQUIPMENT

DESCRIPTION OF UP-TO-DATE APPARATUS FOR LOADING AND UNLOADING OF MATERIAL AND SUPPLIES WHEN SPEED OF OPERATION IS A VITAL FACTOR.

By C. F. KRUMBIEGEL,
Resident Engineer, Montreal, for Deutsche Maschinenfabrik, A.G., of Germany.

THE loading and unloading of material in bulk, such as coal, ore, slag, sand, gravel and the like is a matter of serious expense and consequently of great importance to mines, dealers, contractors, consumers, etc. There is no doubt that in many cases this matter is not given due attention and that the material is still handled in an out-of-date way by unnecessarily expensive labor from ships to cars or storage or from cars to storage or vice versa. One important consideration in this connection is the question of avoiding delays in despatch of vessels and cars and the consequent demurrage on same, as by modern methods a saving of days or weeks can usually be effected.

Fig. 1.—Loading Towers for Handling Large Quantities.

It is a proven fact that modern handling plant will in most cases pay for its first cost in a very short period by the saving in labor, demurrage and risk of accident. Besides these direct advantages there is the fact that such modern handling plants minimize any impairment in the material in the course of conveyance, especially in the case of coal, which, when handled by out-of-date methods, may be crushed and deteriorate in quality. Also, the trend of business and trade will always go to well-equipped plants, i.e., plants with the most favorable conditions for quick service and low prices. These loading and unloading equipments vary in their type and construction according to the purposes they are to be used for.

If the goods are simply to be loaded from boat into cars or vice versa, a slewing crane with grab bucket will be the correct equipment, especially if the boats are not too large or fitted with high masts. These cranes may be stationary or travelling, and driven by steam, as shown in Fig. 3, or by electricity where current can be easily supplied by wire or by a third rail. If it is necessary to clear one or more railroad tracks, the crane can be placed on a full or semi-portal and the jib can also be built to raise in order to clear the masts of the boats. (Fig. 4).

Fig. 2.—Travelling Slewing Crane Running on Bridge Girders.

The capacity of such slewing cranes runs from 4 to 15 tons, including weight of bucket. They may be also

used with advantage for dumping the material into boats from special buckets, which are transported from mines or sand pits to quay by special bucket cars.

Instead of slewing cranes, loading towers operated by steam or electricity are supplied where larger quantities of material are to be handled expeditiously. Nine of such loading towers, shown in Fig. 1, are used for handling iron ore in the Imperial Steel Works of Japan. The hoisting apparatus for the trolley is placed on a small rear cantilever and the very light trolley runs with high speed from boat to the tower, where the ore is dumped into hoppers and from these into cars.

Fig. 3.—Steam-Driven Slewing Crane.

Such towers can be built up to an hourly capacity of 250 tons of coal and a weighing device may be adjusted if desired. In most other cases, where the material is to be stored in piles adjoining the quay, a loading bridge, supported by rigid legs, is the usual equipment. These bridges can be stationary or travelling, and are in most cases driven by electricity. A trolley with grab bucket running either on top or between the bridge girders with high speed, can reach from a waterside cantilever to the outmost hatch of the boat. This cantilever can have the form of an apron to clear the masts of the boats, as illustrated by Fig. 5. This loading plant is built in Rotterdam and consists of 4 bridges with 160 ft. span and 90 ft. cantilever. The trolleys have a capacity of 8 tons each and are equipped with a slewing cantilever of 23 ft., which makes it possible to reach a large part of the boat as well as the storage without moving the boat or travelling the crane.

This is a much better scheme than the scewing bridges where one portal can travel somewhat ahead of the other, which can only be done at the cost of the rigidness of the whole structure. If the waterside apron is not required very large, the jib connected with the trolley can take its part and serves as further extension of a short rigid cantilever. Instead of a trolley with slewing jib, a travelling slewing crane can be supplied, running on the tops of the bridge girders. With this type the structure of the bridge can be kept lower and lighter in construction, having the same advantage of large working circle and avoiding the waterside apron for clearing the masts.

Fig. 4.—Arrangement of Crane to Clear Railroad Track and Vessels' Masts.

A bridge crane of this type is shown in Fig. 2. This crane is manufactured also with a trolley for reloading purposes. This bridge has the interesting feature that the second bridge, if needed as elongation, can be safely coupled to the main bridge in such a way that the trolley is able to run smoothly from one end to the other.

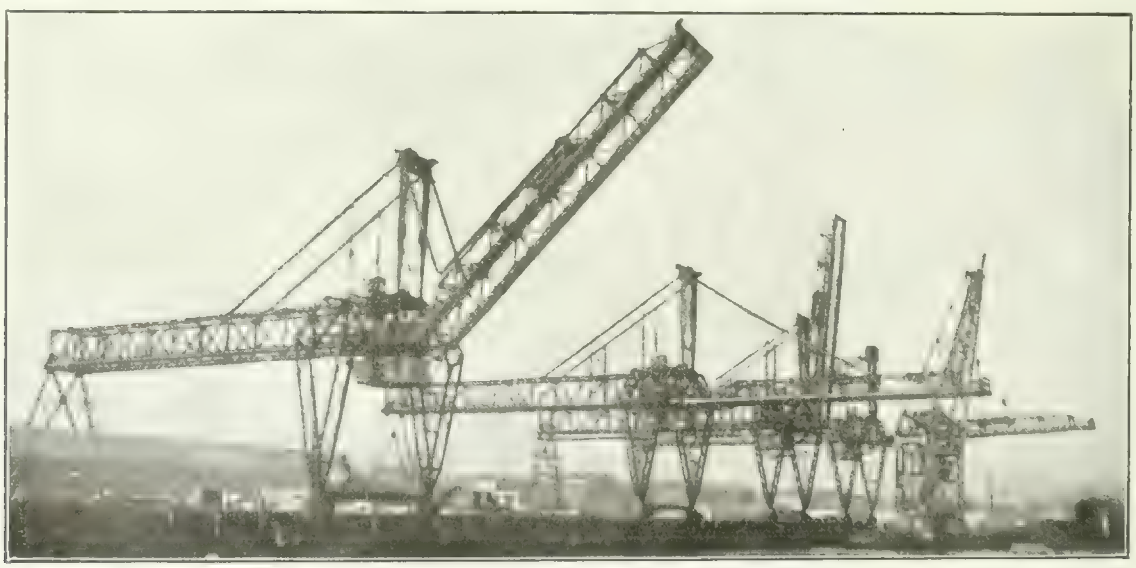

Fig. 5.—Loading Plant with Bridges of 160 ft. Span and 90 ft. Cantilever.

The writer is indebted to the Deutsche Maschinenfabrik, A.G., of Duisburg, Germany, for the photographs illustrating this article, the photographs showing a few of the many loading and unloading devices which have been built by their plants.

THE PETROLEUM INDUSTRY IN 1913.

THE feature of chief interest in connection with the foreign petroleum industry in 1913 was the active prospecting for new oil deposits, according to a statement of David T. Day, issued by the United States Geological Survey. This prospecting extended to very remote regions, including South Africa, southern Chile, Patagonia, many islands of the Pacific, China, Japan, and the East Indies.

The prospecting of most interest to the United States was that in the West Indies, Central America, and South America, on account of the approaching completion of the Panama Canal. In Venezuela American capitalists were actively prospecting in many regions, chiefly along the northern border. More than 20 field parties were engaged in exploration with a view to the selection of the most promising oil fields that might be developed, working under a provisional concession from the Venezuelan Government. These capitalists and others were also actively and successfully developing oil concessions on the adjacent island of Trinidad.

In Colombia, English, American, and Canadian oil interests were concerned with concessions for the development of large areas where, though no large oil wells have been developed, the seepages of oil and asphalt are so significant as to lead to the hope of a large addition to the supply of fuel oil. The Cowdray interests withdrew from Colombia in the later part of the year.

There was a delay in developing the oil fields of Argentina, owing apparently to the desire of the Government to retain the oil as a national monopoly.

In Chile a governmental commission examined the oil and gas indications in the Magellan region and made a favorable report.

In Ecuador the Cowdray and other interests carried on a vigorous campaign for the acquirement and development of areas showing oil indications in the interior, as well as in the region of the old wells near the coast.

Interest was shown in the possibility of finding oil in Panama, Costa Rica, Nicaragua, and Honduras, but so recently that there has not yet been time for a significant result.

In the islands of the West Indies prospecting for petroleum was active in Haiti, where a small oil well was drilled near Azua. In Cuba drilling for oil was resumed near Havana, Cardenas, and Motembo. Explorations for oil were also active in Barbados.

In Mexico development work was remarkably active considering the unsettled condition of the country. It resulted in the development of several large wells in the neighborhood of the great gusher at Potrero del Llano. Another large gusher was obtained at Los Naranjos, on the shore of Tamiahua Lagoon, which indicated a considerable addition to the total oil supply. The importance of these additions cannot well be over-estimated, for in spite of the universal judgment that the Mexican fields are potentially very great the fact remains that so far as present supply is concerned Mexico has been practically limited to two or at best three large wells and not a very large number of smaller wells of most uncertain character. Of the large wells the American (Doheny) interests owned two and the English (Pearson) one. Even with the phenomenal energy of the exploration work it was questionable whether new wells would be found promptly enough, under the peculiar Mexican conditions, to maintain present shipments, let alone supply a combined fleet of about 40 large tank steamers. The supply is now ample. As an evidence of the peculiar character of petroleum commerce, it is probable that with this additional supply the price per barrel will increase, because the greater confidence in the supply will stimulate the adoption of Mexican oil for refining and for fuel.

The 8-in. pipe line of the Mexican Eagle Oil Company (Pearson interests) was completed from Potrero del Llano to Tampico. The refinery of this company between La Barra and Tampico, north of Panuco river, is nearing completion. Among many other interesting developments in Mexico was the continued interest in the Topila oil field, near Tampico, where, in spite of many wells going to salt water, the unusually large gushers occasionally obtained have stimulated continual drilling operations.

A feature of importance for the United States was the development of a large fleet of tank steamers for coastwise and trans-Atlantic trade. Imports of Mexican oil were extended to several refining centres of the United States.

The general interest in the development of new oil fields which characterized the year 1913 extended to Alberta and Saskatchewan, in Canada. Although explorations in Saskatchewan gave either natural gas or else entirely negative results, a well 27 miles southwest of Calgary, in Alberta, struck oil of very light gravity, causing much excitement, and a large territory in that region was taken up by prospectors for oil, probably much more than will be drilled within the next year. This oil excitement extended to the region north of Edmonton, in Alberta, where on Athabaska river and its tributaries, large bodies of so-called "tar sands" have been known for many years. These "tar sands" are in places 60 feet thick where exposed on the river banks and have been traced for considerable distances from the river. Seepages of oil are reported for as much as 400 miles to the north, and many thousands of acres of land have lately been taken up from the Canadian Government for oil development at some time in the future.

Work has continued in the development of the natural gas, petroleum, and oil-bearing shales of New Brunswick.

In Russia the production of oil declined significantly in the larger fields, but meanwhile the Ural-Caspian field was actively exploited. This field is reached by steamers to the north shore of the Caspian sea. There are no wharf facilities yet, landing being made in small boats through the shoal water. About 30 miles from the shore large oil wells have already been obtained, and pipe lines are being laid to the shore where barges can be loaded and towed up Volga river without the reloading necessary for shipments from Baku. Exploration in the Ural-Caspian field north of the present oil wells has been extended over many miles and has shown that the area, while very spotted, gives promise of further development. Exploration in this field is impracticable in winter, but in summer can be prosecuted with success in spite of the great lack of water, the available supply of which is derived principally from snow scraped up in the winter and conserved in pits. The inhabitants of the region are wandering tribes living in tents. They are peaceful and disposed to aid the exploration.

In Galicia deep boring is tending to check the decline in the oil supply and the exploitation has been actively carried forward in all regions where indications have been noted in the past. It is probable that the Government of Hungary will develop the gas wells in the region of Kisarmas.

In Roumania oil production continued active in spite of the very severe fire in the Moreni field. The chief contribution to the industry by the government was the development of a pipe-line system from the producing fields to Constanza, on the Black sea.

In Japan production was greatly helped by the introduction of the rotary system of drilling.

ELECTRIC RAILWAY SYSTEMS.

AN article by Mr. C. E. Eveleth, based upon a lecture delivered by him in New York City, appears in the February number of the General Electric Review, and deals with the present magnitude of the application of electricity to transportation. The author sets down the factors to be considered in the choice, and traces the various features which influence the selection and affect the maintenance of systems. Mr. Eveleth, who is attached to the Railway and Traction Engineering Department of the General Electric Company, distinguishes between the "science" and the "art" of electric railroading in a very interesting way. His article is as follows:—

When considering the subject of electric railway systems it is well to bear in mind that only twenty-six years have passed since the first electric motors propelling street cars in Richmond startled the people by the terrifying flashes at the overhead collector and from the motor brushes. As in any radically new enterprise the pioneers were called upon to bear the brunt of development and to overcome what appeared to be almost insurmountable difficulties. The improvements made in the various elements were so rapid that soon the electric motors not only displaced horses as motive power, but also led to the extension of the field of city transportation. Then there followed the development of many thousands of miles of interurban electric lines, which have brought the outlying farms close to the cities in almost every locality east of the Mississippi river. This network is being steadily extended and will eventually cover the entire country as the density of population increases. The effect of the inter-communication so afforded is incalculable, both from an economic and sociological standpoint.

It is interesting to know, in these days when so much is heard about the increased cost of living, that such elements in our daily lives as are served by electricity have steadily decreased in cost, and to-day we ride farther for a nickel and have more electric light illumination for less money than ever before. Is it not significant to learn that the only divisions of one of our large eastern steam railroads where the net earnings per passenger car mile are holding their own are on the portions operated electrically, while on those divisions not so operated the net earnings are only a fraction of what they were seven or eight years ago and are decreasing at an alarming rate?

We sometimes ask: when will our railroads be operated electrically? In a recent lecture by Steinmetz, the statement was made that there is more aggregate horse-power in electric motors operating cars and locomotives to-day than the aggregate horse-power capacity of all of the steam passenger locomotives used for transportation in this country. Based upon this, we can fairly say that electrification is here now. The day has not yet arrived when the universal electrification of our steam railroads can be economically accomplished, but the decreasing cost of power and the lower cost of electric equipment for rolling stock is gradually extending the field where the application of electricity to transportation is justified and will eventually permit electricity to replace steam on all important railroad divisions.

At present we are using electricity to accomplish results unattainable with steam engines, notwithstanding the magnificent accomplishments which the steam engine designer has achieved with the Mallet locomotive, oil-fired boilers and the use of super-heated steam. Of all known agents, electricity is the most convenient means of distributing power and its application to transportation successfully overcomes widely different limiting conditions. On some railroad divisions about one-twentieth of the gross ton mileage is used for hauling the coal to supply the steam locomotives with fuel; on other sections, the speed on going up grade is limited by the boiler capacity of the engines. The operation in descending these same grades is frequently hazardous, owing to the possibility of the loss of air for the air brakes, or danger from overheated brake shoes and wheel tires. Applying electric locomotives to these conditions, in many instances, eliminates entirely the freight tonnage required to haul fuel. We are able to increase the speed of freight trains up grade to the maximum safe or economic limit, and by the use of regeneration we not only lessen the danger from failure of air for the brakes and the heating of tires and brake shoes, but are able to actually recover a material portion of the energy given up by a train descending a mountain and utilize this power for ascending trains. We are able to overcome the difficulties incident to bad water found in desert regions on one hand, and to more quickly transport the suburbanite on the other. Other limiting conditions which can only be met by electric traction are the elimination of smoke, the better utilization of space in city terminals by the use of differnet track levels, the elimination of round houses, turn tables and the saving of time required by steam locomotives while going for water and cleaning fires.

There are two broad divisions of the subject under consideration; one might be called the "Science of Electric Railroading," and the other the "Art of Electric Railroading."

The "Science" has to do with all the fundamental details which enter into the present development and includes the work of improvements and invention, which are necessary to broaden the field of electric traction. This includes developments in insulation, designs of generating, transmission, conversion and rolling stock equipment parts, the solution of problems of current collection, the mechanical structure of locomotives for high speeds, and the many elements which go to make up a successful and economical system of control for the electric power from the prime movers to the train wheels. There are thousands of men employed in the development of the science of electric railroading, and it is to these men that we shall be indebted for the final victories of the electrification.

The "Art" of electric railroading includes the analysis of conditions and the selection and application of the available elements to a specific problem as well as the operation and maintenance of the finished system.

It is the problem of the electrical engineer to so select and balance all the elements of power generation, transmission, and consumption in such a manner as to deliver the desired quality and quantity of transportation with the greatest reliability and the lowest cost.

As set forth, the problem seems simple, but experience has indicated that very different conclusions are reached, both as to the methods which should be applied and the anticipated results. The problem is, in fact, extremely complex; so much so that it is almost impossible to retain in mind the many elements which must be simultaneously considered to reach a justifiable conclusion. Frequently one sees results cited, which, on analysis, are found to disregard entirely elements of the greatest importance.

A better comprehension of the situation can be obtained by outlining some of the elements which must be equated. We will assume that the problem as to schedules, train capacities, grades, etc., both for the present

and future, has been accurately set forth. For conditions requiring the use of motor-car trains and locomotive operation, there are available for consideration direct current and single-phase equipments or possibly single-phase for the motor cars and split phase for the locomotives, with a further possibility of three-phase, if the problem involves the use of locomotives only. To reach the proper conclusion every element from the prime movers to the train wheels must be considered.

Power Supply.—In some sections of the country, in the Carolinas, Michigan, Montana, Washington, Oregon and California, for instance, we find networks of power distribution which range from five hundred to two or three thousand miles of transmission circuits in each system. Generally in such localities, it is more economical for a railroad to buy than to manufacture its own power, since this requires less capital expenditure, and the power companies which have the benefit of diversified load factor, can, generally, manufacture power for less cost. Where such conditions exist the frequency of the primary distribution is established by these systems. Where it is necessary for the railway to build its own power house, the question of frequency with its bearing on the power already available in the territory to be served and the demands of the particular rolling stock selected must be carefully investigated. Comparisons must be made between single-phase and three-phase power generation, due weight being given to the elements of initial cost, efficiency, power-factor and protective appliances. Some of the problems, such as the desirable size of power house units, their overload capacity, etc., is common to all unit systems.

Distribution System.—This is the simplest element in the chain and can generally be worked out on its economic merits as regards the selection of voltage, size of conductors and the character of installation to conform to the distance of transmissions and permissible line regulations for the various systems.

Secondary Distribution and Substations.—The location and capacity of substations must be considered jointly with the secondary power distributions to the trains. This involves the selection of voltage; the determination of the permissible potential drops; provisions for the mitigation of inductive interference with telephones and telegraphs for the single-phase and three-phase systems, or the consideration of the possibility of electrolytic difficulties in case of the direct current, both for normal operation and for conditions of short circuits; the selection of third rail or overhead trolley; the effect of atmospheric conditions, such as lightning, snow and sleet; examination of the reliability of the elements chosen and decisions regarding the amount of line to be incapacitated when local repairs must be made. The selection of substation apparatus will be different for each system, and will further vary with the frequency of power supply. The advisability of using transformers or auto-transformers with questions of capacity and regulation must be considered for the alternating-current systems; and with direct current, there are questions of the relative merits of motor-generator sets, rotary converters or motor converters with the determination of their normal and overload capacities and regulation. To make these different elements comparable, the selection of apparatus must be so balanced as to yield the same degree of insurance in case of the failure of individual elements or abnormal congestion of traffic, due to any cause.

Rolling Stock.—This item is by far the most important, as the proper selection of these elements is vital to the success of the system. Here we are at once confronted with the consideration of the inherent features and costs of the various kinds of apparatus available, and due consideration must be given the relative values of constant versus variable speed, features involving the starting characteristics, efficiency of motors, conversion devices, control and driving mechanisms, effects of inherent characteristics on power load factors, electrical power-factors, etc.; in addition, the desirability of regeneration and emergency braking require consideration, if mountain work is involved.

After having determined the first costs and rates of depreciation of each of the above elements, there remain two important items for consideration. The first is the analysis of power consumption, which can be carried through with reasonable accuracy for the particular conditions under consideration. The second is the problem of the determination of the operating and maintenance costs, which is more difficult. It is in these elements that the results of practice are most often lacking, and the value of an individual's judgment will depend on his general experience, and on his ability to deduce from available data information which can be applied, when properly modified, to meet the specific problem in hand.

General.—The assembly of these elements in the order of their relative merits is the problem before the engineer who is called upon to select a system for a particular application. It is not surprising that different results are reached by different investigators, due to the different weights assigned to the elements or difference in the degree of optimism towards some of the unproved features. Very often it is surprising to find how little difference there is in the initial costs of the various systems, as some of the elements tend to offset each other. For example: the high cost of single-phase rolling stock equipment frequently offsets the greater cost of direct-current substations, while the additional weight of the single-phase equipments offsets the greater conversion losses of the direct-current substations, resulting in both the cost and power consumptions of the two systems being almost identical. Consequently, with a greater quantity of rolling stock, the tendency is for the moderate voltage direct-current systems to be lowest in cost and cheapest to operate, while with few rolling stock elements the tendency is to relatively favor the higher voltage systems. For suburban electrifications a moderate direct-current voltage is generally the most economical, while for single-track infrequent service, higher voltages are desirable.

A discussion of electric railway systems would not be complete without consideration of the Standardization of Systems. There is no doubt but that standard third-rail and overhead trolley clearances are necessary to avoid serious interference with bridge girders, station platforms and various structures existing along main railway rights-of-way. About seven years ago, the Germanic countries, headed by Prussia, adopted certain arbitrary standards that all main railways should be equipped with fifteen thousand volt single-phase trolleys operated at sixteen and two-third cycles. At that time there was no experience available to justify such a selection, but it was believed by those in power to be desirable to have all efforts expended in one direction, and, furthermore, it was deemed necessary for military reasons. Since then, it has developed that the limitations imposed are very adverse to economical motor car operation, that inductive interference with telephones and telegraphs under certain conditions are extremely serious, and the low frequency involves difficult mechanical problems and practically bars out forever an economical design of induction motor for certain classes of service. These limitations are rousing some dissatisfaction in Germany; the

Italian engineers have decided that three-phase is better suited to their conditions, and the majority of engineers in England, Australia, Canada, France and Russia seem to favor direct current.

In this country we have done well to avoid a limitation such as an arbitrary standard system of electrification would impose, since it leaves us free to work in every direction, whether it be single-phase, three-phase, split phase, moderate or high voltage direct current, the mercury rectifier systems, or in any other direction which may be entirely unknown to us to-day. Arbitrary standardization of a system would mean limited development or stagnation.

Electrification of railways is desirable, not only from the standpoint of superior transportation, but on account of improvement in land values and the comfort and safety of travel. Although electrification is economically justified for many conditions, there are to-day no known systems sufficiently low in cost to permit universal use of electricity for railroads, and we must, therefore, have a free hand in order to achieve the ultimate general application which we believe will come.

WATER TOWER AT ST. VITAL, MAN.

THERE has recently been erected for the Agricultural College at St. Vital, Man., a water tank with a capacity of 125,000 Imperial gallons. The structure is mounted upon a tower, the total height being 160 ft. The weight is somewhat in excess of 100 tons. The cost, including foundations, was approximately $16,000. Fig. 1 shows the tower and tank completed.

Where such a means of water supply is resorted to in climates that are subject to severe freezing in winter time the main issue to contend with in the design and construction is to arrive at some feasible means to prevent freezing. To this end it will be noted that a riser pipe has been employed. It is built of steel, 6 ft. in diameter, the idea being that the diameter is sufficiently large to permit the formation of a natural frost jacket of ice about 3 inches thick on the interior of the riser pipe, protecting the balance of the cross-section from freezing. As an added precaution a 1½-inch steam coil, to the extent of about 100 ft. was placed in the bottom of the tank for the purpose of raising the temperature of the water.

On account of the excessive range in temperature, as well as owing to the great height of this tower, a second difficulty was encountered in attaching the riser pipe to the bottom of the tank. Obviously the variation in temperature from season to season is greater in the posts of the tower than in the riser, since the riser pipe maintains a more constant temperature than the outside air. Some provision had to be made necessarily to take up the difference in expansion and contraction between the posts and the riser pipe produced in this way.

It was deemed inadvisable to use the tank bottom as an expansion joint. To get over the existing difficulty the riser pipe was equipped with an expansion joint of large diameter at the point where it enters the tank proper. In this way the builders were able to retain the hemispherical bottom tank, which is claimed to be the strongest type in use. Another important point characteristic of this form is that the very steep slope of the bottom portion of the tank allows accumulating sediment to drain into a main drum, at the same time allowing the added advantage of the large steel riser pipe.

In order to insure a minimum of sediment and dirt in the water, the 12-inch inlet, which enters the large riser pipe at its base, has been carried up a distance of about 4 ft., thus forming in the bottom of the riser the mud drum, mentioned above, for the collection of sediment, etc., which may then be drained off. The extreme bottom of the riser pipe has been equipped with a quick opening flow-off valve so that this sediment can be carried away quickly and completely and the tank cleaned without emptying the structure.

There is also a valve chamber directly underneath the large riser pipe and below the surface of the ground, in which the pipes of the sewer system are so arranged that the water may be pumped directly into this system

Fig. 1.—Tank and Tower Recently Erected at St. Vital, Manitoba.

without going through the tank, or may be pumped directly into the tank with the same inlet and outlet, using the tank as a pressure regulator, or the water may be pumped into the tank by one pipe and discharged in the mains by operating 3 valves in the valve chamber.

The Des Moines Bridge and Iron Co., Des Moines, Iowa, furnished and erected the structure.

WATERWORKS OF CANADA.

At the 5th annual meeting of the Commission of Conservation, held in Ottawa last month, it was announced by the chairman, Hon. Clifford Sifton, that a new edition of "Waterworks of Canada," by Leo G. Denis, B.Sc., Hydro-electric Engineer of the Commission, would probably be issued. The first edition had been much in demand, especially in the rapidly growing towns and cities of the west, where the necessity of installing waterworks systems was becoming more urgent year by year. The new report would bring up to date the previously published data, and would be much more extensive in its survey of existing systems as they are at present.

The 1912 edition contained a number of charts and tables, summarizing the information in the body of the work and emphasizing points of special interest, such as the growth of the principal systems, sources of supply, rates, cost, consumption, etc. This will be extended and made still more authoritative.

HIGHWAYS AND HIGHWAY SURVEYING

PRACTICAL SUGGESTIONS APPLICABLE TO PROBLEMS OF ROAD FINANCING AND ENGINEERING—OUTLINE OF SURVEY WORK, AND EXAMPLES OF ESTABLISHED METHODS.

By DANIEL J. HAUER
Construction Economist

EDUCATIONAL work among the public as to the value of good roads is about over. The humblest farmer now appreciates the fact that good roads mean better living for him and easier methods of obtaining it. The questions now before both laymen and engineers are "What to do and how to obtain better highways at a reasonable cost?"

Road Financing.—The greatest mileage of roads on the American continent consists of the unimproved dirt roads, the so-called farm roads, leading from the farm to the nearest towns and villages, or to the main travelled highways. The roads surrounding our large towns and cities can be easily improved, for it is not a difficult matter to raise the money to rebuild these highways. But it is a serious problem to obtain money enough to make passable the thousands of miles of dirt roads.

There are two methods in common use, namely, direct taxation, and the issuing of bonds. There must be a limit to direct taxation and especially in small communities; so most road enthusiasts turn to bond issues to obtain the necessary money. Bonds must be redeemed at maturity, if the credit of any province, county or town is to be maintained. This, together with the limitations set by law, must govern the issuing of bonds. Thus it becomes evident that long-term bonds should not be issued for road building and improvements. For building reservoirs, sewers, canals and other structures that last for many decades they are justifiable and economic, but for street and road work, the term of the bonds should not exceed the life of the road. Few road and street surfaces last more than a decade, so it is a mistake that will finally bring disaster to the community that sells long-term bonds for roads and streets. Many cities and counties are suffering now from this indiscretion.

The Highway Engineer a Necessity.—This and many other considerations, to be mentioned, may not seem germane to the title of this article, but nevertheless such considerations affect highway engineering and surveying, and the highway engineer must keep them in mind. It it part of his duty to guide the public, as he alone, of public men, is fitted to prevent the taxpayer and our lawmakers from making these economic blunders. This is plainly shown by the waste of money made by those communities that have not had the advice of engineers or have acted contrary to such advice.

A common blunder made in the past, and still being made, is the general belief among public officials and the general public, that any intelligent man can build and maintain roads. This one thing has been the cause of wasting many thousands of dollars. In Eastern Canada, where the writer is familiar with the conditions, he does not hesitate to say that on the common country roads, one-half of the money now being expended is being wasted due to inexperience and a lack of knowledge of road engineering and construction. Road building and maintenance is a profession, and if the taxpayers are to obtain the best possible results for their money, they must see to it that only competent men with the requisite knowledge are employed for highway work.

At present, this is the most difficult task in road construction, due to the fact that we have such road laws that prevent obtaining competent men, and even if some are placed in charge of such work, the system under which they must labor prevents them from obtaining a dollar's worth for a dollar.

Need for Revised Legislation.—Those interested in better highways must first see to it that our road laws are changed. Small towns and rural communities are not capable of looking after their own highways. They neither have the money to employ competent men nor to purchase the necessary plant to build and maintain our highways. Hand work is too expensive to be tolerated any longer on roads. The need of conserving the available money to obtain all the improvement possible is too great to allow of obsolete methods being used.

The system of small communities looking after their roads dates back to feudal times in England. Each castle and mural town was cut off from others by vast forests infested by robbers, making communication hazardous and difficult; so that each community was compelled to build and maintain its own roads. Thus the local roads were kept in fair condition, while those through the forest were nothing more than muddy tracks. As the forest highwaymen were driven out the work on the town roads was carried into the forest and these roads made passable; but the old system continued, was brought to America, and in many sections is still in vogue.

There should be no smaller unit for road building and maintenance than a county. Thus a province or state and the general government, in giving road aid, can deal with one community rather than with 50 to 100 small units.

With the road tax paid into the county treasury, each county can have an expert highway engineer and under him can be competent assistant engineers and road supervisors. The proper machinery can be purchased, or the work can be let at contract, so that the most economical methods can be used. With this system the proper field and office work can and will be done.

Engineering is essential, no matter under what system highway work is done, or whether it be new construction, reconstruction, or maintenance. Thus highway surveys must be made. Almost any surveyor can run a line, but this is not surveying. For highway work it is essential that surveys be made with judgment and that they be complete in every detail, both as to surface of the ground and sub-surface. This brings us to the real consideration of highway surveying.

Establishment of Road System.—If only a single road is to be improved the survey can be started at once, but if a system of roads for a county or province is to be devised, then before the surveys are made a tentative road system must be laid down on a map, subject to

changes that will be found expedient to make after the surveys are to be made. Money may not be available for improving the entire system at the outset, but this should not prevent preliminary work from being done; for it is evident that if a comprehensive system is devised at the start, it is possible to expend the money for years to come with a definite policy in view and to obtain the best possible highway. Slight changes in roads and in policy may be deemed expedient, as the work progresses, but changes of administration and of officials need not affect the general policy or system of highways without this office planning (to the public seemingly time and money wasted) each administration will inaugurate new schemes, change methods and money will be wasted as it has been in the past.

In laying down a system of highways there are many considerations to be kept in mind. First, should be the farming and commercial interests. It is hardly necessary to consider the automobile. Although we owe much to the automobile interests, in as much as they have wised the public to the need of good roads, and by their concerted action and labors have made better roads possible, yet build a good road and the automobilist will find it. A few miles of extra distance means little to him, and, after traversing all the roads, he will select the scenic ones for his touring and joy rides. However, in deciding upon the road surface the automobile must be kept in mind for, next to water, the rapid moving car is the greatest destroyer of road surfaces.

The Most Needful Roads.—Those roads serving the greatest number of people should be laid down first, carrying merchandise and produce from the towns and railroad stations to the farming, mining and manufacturing centres, and vice versa. The fact that such roads may be longer than the more direct routes should be ignored, for, to be of value, the roads must go to the people. It is wrong to build a road through a country rather than in it. There may not be money available at the outset to build the long system of roads, as against a short and more direct system, but this is not a valid reason against planning the system, for ultimately the money will be provided and the sooner the proper officials and public know what is needed the sooner the financial arrangements can be made. Population and valuation must be considered in this connection which precludes roads from being built on air lines through undeveloped country. These last roads are an after-consideration.

To call a system of country roads "trunk lines" is a misnomer, and frequently injures the work being done and the raising of money for roads, in the eyes of the public. A trunk line is a through road, meant for quick communication between central points. Roads should be named from the source of deriving the money to build and maintain them. Thus the various systems should be known as County Highways, Provincial or State Highways, National Highways, etc. After these systems are built to serve every hamlet and farming district, then direct routes can be selected and re-built, to be designated as trunk lines. These should embrace those roads having the heaviest traffic and, if necessary, short-cuts and new air lines should be laid out.

A further need of improving the roads that lead to the farm is the high cost of hauling produce per ton-mile, which is paid directly by the consumer, and the high cost of hauling farm supplies, which is paid indirectly by the consumer of farm products. Then, too, improved roads tend to keep the young country boy at work on the farm, which is necessary to-day, as our rural communities are being rapidly depleted of the choicest of their young manhood.

In planning a system of highways, the various roads or lines can be designated by letters and numbers and also by towns as, Highway A, Highway No. 10, Section No. 20, and the Charlotte-Mecklenburg Highway.

Engineering Staff Organization.—A tentative system of roads once devised, the work of surveys can be commenced. For this there must first be an organization that will allow thorough work to be done, but will be flexible, being able to curtail it as circumstances warrant it and being enlarged as the amount of work increases.

A chief engineer is the first requisite. He may be the commissioner of roads himself or he may be an official of such a commissioner or commission. Under him there should be an office assistant, an engineer, who remains in the office, acting for and under the direction of the chief; an office draughtsman; a filing clerk, and a stenographer. This force can be increased as the amount of work warrants it. There can be principal assistant engineers, assistants, district engineers, chief draughtsman and assistants, and other engineers and clerks. Or, with only a limited amount of work, the office assistant can do all the necessary drawing, and the filing can be done by the stenographer. It may even be possible to combine all four positions in one.

The system of roads, if too large to be looked after personally by the chief engineer, should be divided into districts and over each district should be an engineer-in-charge. If his district is large he may need an office assistant, who should be a draughtsman, and a stenographer; but for a small district, he should be able to look after this work himself. Under the district engineer should come the field parties.

If there are more than two or three field parties, assistant district engineers should be used, each man having charge of two or three parties. These district engineers and their assistants should be the resident engineers of their district, so as to be in touch at all times with their work. It is an expensive policy to have an engineer in charge of each field party. This resident engineer is not necessary as the district engineer can visit each field party several times a week, spending such time with them as is necessary to guide the work of surveys and decide on all doubtful points. A chief of each party means extra salary and expenses, and the results obtained are not commensurate with the money expended.

The transitman can be the chief of the party. Under him should be the levelman, who runs the level and, if necessary, substitutes at the transit. The level rodman completes the level party. In the transit party there should be a head and back chainman, a rodman and a stakeman. These last two can run the back rod, make stakes and hubs, drive and number them, and carry the extra equipment. The back rodman can be dispensed with if absolutely necessary, but as his wages are small and as the increased work that can be done through his help more than offsets his salary, it is the part of wisdom to employ him. With this extra man it also becomes possible to have the transitman go ahead at times to lay out the work for a mile or so, while the head chainman runs the transit and the others chain and place the stakes. The writer prefers to employ a back rodman rather than an engineer-in-charge for each field party. As previously explained, one man can look after several parties.

The Plotting of Field Notes.—It is a common practice to-day in some sections to employ a field draughtsman. This, the writer believes, is unnecessary. Notes

should be plotted in the field, rather than in the office of the chief engineer, and it is seldom necessary to employ a special draughtsman for this purpose. If notes are plotted in the field the party, seeing what is done each day, is able to work more intelligently, and to make more complete surveys. If anything is overlooked it can be taken up before the party has gotten too far ahead.

Each day the levelman, with the assistance of his rodman, should work up his field-notes and plot the profile, especially of the transit line. The cross-sections and side elevations can be plotted on rainy or stormy days. The transitman, with the assistance of the head chainman, can plot the alignment each night, and on stormy days houses can be plotted on the map and other side notes completed. It is not a great hardship on the men to do this work and they derive benefit from it, as it makes them more careful, besides learning to do much that will be the means of bettering their positions. This, too, means the saving of a field draughtsman's salary, which could be added to the pay of those already employed, or effect a clear saving.

If notes are sent to headquarters they are always slow in being plotted. The notes may be inaccurate and incomplete, and with the field parties disbanded the results may be exceedingly unsatisfactory. From notes made in the field tracings can be made and sent to headquarters. On these, new locations and grades can be placed, from which notes and blue prints can be made and sent back to the surveying parties to be used. This makes a complete organization for surveys.

Alignment.—On the actual work of surveying, the first thing to be considered is the alignment. A complete survey should be made of the present roads. This is best done by running a transit line as near the centre of the road as possible. It is a very easy matter to say to keep in the centre of the road, and it can be done with long, straight stretches, but on very crooked roads with sharp, abrupt turns, it is quite a difficult task to do, and at the same time make a fair rate of speed in the surveys. It is evident that if the road is to be re-built on exactly the same line, then it is money saved to take the time and trouble to get the transit line exactly in the centre, as then the preliminary line answers for the location. But if improvements are to be made in the alignment, then it matters little if the transit line is not always in the centre; for a line must later be located on the ground at the proposed centre, the only difference being that in running levels fewer are needed if the transit line is in the centre of the road.

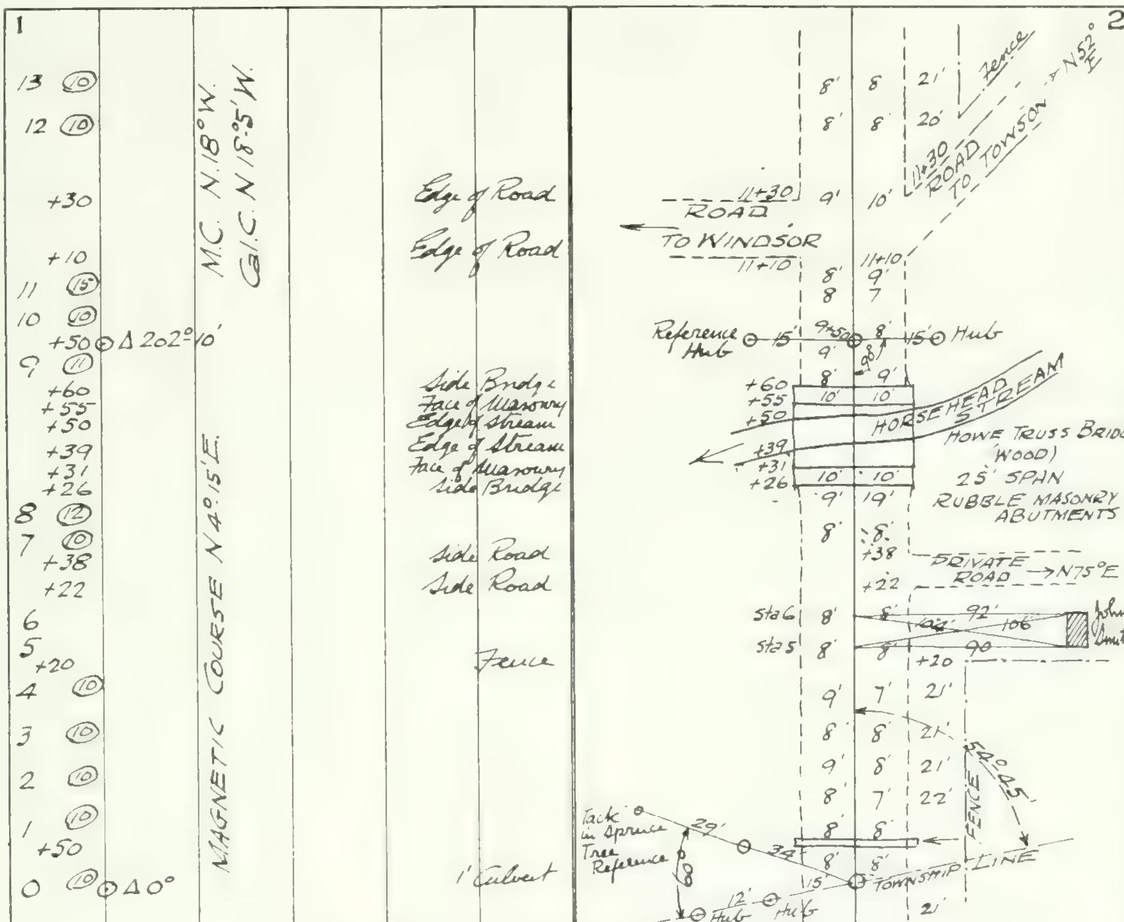

Fig. 1.—Sample Page of Transitman's Note Book.

Establishing Reference Points.—To start the survey, a point is selected at any definite place, as at the intersection of two roads, a town line, an established meridian, etc. It is not possible to drive wooden hubs into the roadway, as they will be destroyed by the traffic. A better plan is to use spikes for transit points. An 8 or 9-in. spike will give a good mark. A boat spike is preferable, as it does not bend as easily and has a good head on it, but a wire spike will answer the purpose.

Then the transit line should be projected straight along the road in the direction in which the survey is to run to the first turn or top of the first hill. To tie this line in, an angle should be turned between the projected line and that already established, at the intersecting road, town line, or meridian. Then a magnetic course should

be read on each line. The point established thus, becomes zero, the angle and magnetic courses give the location of this point, and the work of chaining is ready to commence.

A station is made every hundred feet. At each station the distance is measured to each side of the road, to the fences, if any, on each side, and to other features that may be found. The plus stations of all culverts, pipes, etc., are taken, and the measurements to each end from the transit line, all being recorded in the note book. Before moving the instrument ahead, each transit point should be referenced.

The easiest way of referencing a transit point is to turn a right angle to the transit line (this should always be to the back line, and not to the newly projected line; uniformity in this will prevent mistakes afterwards); measure off on each side a given accurate distance and put in a hub with a tack in it on each side. This method is accurate enough if the ground is about level, and if little if any grading is done afterwards; but if the ground is rough, or if a deep cut is afterwards made or an embankment built, the sight of one hub from the other may be obviously cut off and there is a chance of varying in making measurements.

A more accurate and satisfactory method is by means of two sets of hubs, so placed as to interset at the point to be referenced. For cuts, a hub on each reference line on each side of the cut will answer, but for embankments the hubs should all be on one side of the road, or at least the two hubs on one line should be on the same side. This allows the point to be placed back on the transit line by an intersection, measurements being entirely unnecessary. As near as possible, these reference lines should be at right angles to one another, as better work can be done in replacing the point. This, though, is not absolutely necessary. It is well to make measurement from the transit point to the reference hubs, as this is an aid in locating them afterwards, especially if bushes have grown up. One of the two reference points can often be placed on a tree by blazing and driving in a tack. Other methods of referencing will suggest themselves, but the last one described, with variations to suit local conditions, is the safest and best.

Party System.—In running the transit line the work can be divided as follows: The transitman runs the transit and keeps the notes. The head chainman makes all the measurements and calls them out to the transitman. He selects the places for hubs and spikes. He runs the front transit rod or flag, giving all foresights. Under his direction the rest of the party works. The back chainman holds the back end of the chain, assisting in making measurements, calls out the last station number, and carries along any extra stakes. While the transitman is moving up the back chainman assists in making hubs and stakes, or in cutting away bushes and trees that may be in the way. The head chainman should be ready at all times to set up the instrument for the transitman, should the latter need the time to make record of notes.

The axeman makes the stakes and hubs, carries a supply along with him, marks the stakes, calling back the numbers to the back chainman. He also drives the stakes and hubs, and assists the head chainman in making side measurements. The back flagman gives a back sight whenever needed, makes stakes and hubs in his spare time, and, if necessary, helps cut out bushes and trees. He carries along any extra baggage. Every man in the party should be provided with a piece of keel or marking crayon, so that time be not wasted in marking or re-marking stakes.

Features of Importance in Transit Work.—In placing the spikes or hubs, the latter should be used whenever possible, i.e., when the points come on the sides of the roads, as they will on sharp turns; they should be placed at some foot mark, or, if possible, at a station or plus 50, as this makes plotting easier and more accurate. Generally speaking, every transit point means that there is an angle in the line. A few may be points on long tangents, but these can be treated in a manner similar to those that have angles.

There are two methods of turning angles in highway surveying. The first is to take a back sight with the vernier set on zero, then reverse the telescope of the instrument and turn the angle ahead to the right or to the left. The other method, which is in more general use, is to have the vernier set on zero and, without changing the telescope, to turn the angle through the entire arc. Thus an angle to the right will be less than 180 degrees, while an angle to the left, by the first method, will be more than 180 degrees. On a tangent the angle turned will be 180 degrees. When this method is used the angle is always turned to the right, that is, through the entire arc on the right of the transit line.

"Right" and "left" in surveys should have a distinct meaning. Standing facing in the direction in which the line runs, everything on the right is known as "the right" and the other side as "the left." No matter how the work is done afterwards, these two terms always mean the same, even if part of the line is run backwards. In working on the surveys all notes should be taken on the right at each station or plus, and then the left side is done. There are several advantages in this: (1) nothing is likely to be overlooked; (2) this saves calling back to the transitman upon which side the notes are being taken, as he knows everything is done on the right before his men go to the left; (3) the party soon becomes accustomed to this and thus useless steps are and time is saved, and (4) men knowing these facts are less likely to make mistakes.

All offset stakes should be set on the right, and all guard stakes on the same side, the marked side of the stake facing the point. Thus there can be no doubt as to where to look for these points.

The surveys made around improved property should be very complete. All houses and buildings within 100 ft. of the road should be located and general dimensions taken. The houses can be located from two stations, taking a measurement from each station or plus to each corner of the building, making four measurements in all. All private and public roads or cross roads touching the highway should be located on the centre line and the magnetic course of them taken. They should be measured to the house or for at least a distance of 200 ft. The width of such roads should be taken, or other important features noted.

For bridges, the plus of each side, the direction of the flow of the stream, the span of the bridge, and the width of the stream, if it varies from that of the bridge, should all be taken.

The notes for all of these should be recorded in the transit book. Extensive road improvements generally cover a period of many years, as the laws or acts furnishing the money frequently provide that a stated sum shall be expended annually, for a given term of years. This means that many changes are bound to be made in the engineering corps, so it is absolutely necessary

that all notes and records should be made in a manner that will not be confusing or difficult to understand.

Fig. 1 shows the two pages of a transit book, Station (Zero) O starting at a township line. The width of the road, i.e., the beaten track of travel, is shown at each station, and the distance from the centre line to the fences. A culvert is shown at Station 0+50 and a bridge at 8+26. A farm house with a private driveway alongside is shown between Stations 5 and 6. At Station 11+10 are shown cross roads. Magnetic courses are taken on all lines and roads, as shown in the notes. On the transit line the magnetic course is taken and from it and the angles calculated courses are recorded. If the road-building is to be done at once this is all that is necessary, but if the work is to last over a number of years it is well to take into consideration the magnetic bearing from the true north. At Stations O and 9+50 are two transit points. The two methods of referencing these points are shown, viz., at Station O by two lines with two hubs on each, and at Station 9+50 by two hubs at right angles to the back tangent. The notes are run up the page, although some prefer them downwards. The writer's preference is to start at the bottom of the page. Then the notes are kept as the line is run and the man facing the line has his notes in the same position, preventing mistakes being made in recording measurements on the right and left.

In making the surveys, all the work should be done in a systematic manner. The transitman should keep his notes up in the field, leaving nothing to be put down at night. He should, as soon as he sets up his instrument on a new point, take a back sight and reference the point. This gives time for the flagman or chainman to go ahead and establish a foresight, which can be changed to suit the men chaining if necessary, as the first point may be found to be 9+42.6 which can be changed to 9+50. Then the transitman should read his angle, meanwhile letting his needle swing to take the new course. This done, the work of chaining can be started once more. As each station is measured in, the side measurements should be made and called back to the instrumentman, or recorded in a temporary note book if the distance is too great to call. It should be made a rule to take all measurements to the right before going to the left. This prevents confusion and mistakes, saving much calling of names, as at Station 13 it will be seen that the first measurement, 8 ft., means to the edge of the road on the right, the next 21 ft. from the transit line means to the fence on the right, then 8 ft. on the left means the edge of the road, and with the chainman going ahead the transitman knows there are no other notes to be taken. Men can work several thousand feet in front of the instrument in this manner without confusion or error.

It is not possible to drive stakes on the transit line, except when the line is run on the side of the road or for a trial line. Then the stakes should be driven at each station, with the marked side facing the instrument or zero point. When the stake cannot be put at the measured station, it should be offset to the right-hand side of the road, always on the same side, and at right angles, as near as possible, to the transit line. The marked side of the stake should face the station point and the offset in feet should be marked on the stake below the station number, with a circle around it. This same offset should be recorded in the transit book at each station with a circle around it, as shown in Fig. 1. This allows of the stake being found easily if it is broken off, and is a help afterwards. To save time these offsets can be marked in the book on a rainy day or as the party is going over the line later.

At hubs or spikes the guard stakes should always be set to the right with the marked side facing the point. Uniformity in this is a great help afterwards. At all pluses, references, etc., it is well to mark the station number on the stake, as well as the plus or reference. Then, if the stakes are pulled up there can be no question as to where they belong. This means the saving of much time afterwards. At all transit points the guard stake should first be marked to denote that this is a hub or transit point. In marking stakes, space should be left at the top to mark a letter, as this line may afterwards be given a letter to denote it, or an "L" may be placed on it to show it is a located line upon which improvements are to be made.

Each night the transitman plots up his notes, and if any data has been overlooked it is taken the first thing the next morning. It is not well for him to use ink on his map until it is to be finished or sent to the office of the chief engineer.

(To be continued.)

CONSERVATION REPORT ON TRENT WATERSHED.

A report, entitled "Trent Watershed Survey," by Dr. C. D. Howe and J. H. White, of the Faculty of Forestry, University of Toronto, with an introductory discussion by Dean Fernow, will shortly be published by the Commission of Conservation. The area investigated is one in which the conditions are typical of those prevailing over thousands of square miles of cut-over lands in the Eastern provinces of Canada and for which it is desirable to formulate a policy of reconstruction and recuperation. The Dominion Government has a special interest in this region, as the capital invested in the Trent Valley Canal system amounts to upward of $10,000,000.

The report covers farming, forest, industrial, mining and tourist traffic conditions in the area considered. It shows that only 15,000 people inhabit the 2,100 square miles of the watershed (a decrease since 1901 of 15 per cent.), and that hardly 10 per cent. of the region has been cleared for farm purposes. The soil is altogether unsuitable for agriculture, and run-down and abandoned farms are to be found in large numbers. Nearly 200 farms were for sale for unpaid taxes in 1911 at 6 cents per acre.

Practically all the pine has been removed. The whole area has been burned over at least once. Almost one-half the area is covered with young and second-growth trees of the poplar-birch type, the result of fires.

It was found, however, that enough hardwood and wood of the poplar-birch type remain to warrant the adoption of a policy of conservation, and Dominion, Provincial or municipal ownership of the territory in question is suggested by the Commission as an initial step in that direction. Other recommendations are: the re-possessing by the Province of the licensed lands which have practically ceased to produce the quantity of logs contemplated under original licenses; the imposing of restrictions on existing limit holders, tending to protect the forest growth; the appointment of a forester charged with the surveillance of the region; the perfecting of a fire-protection organization, building of look-out stations and watch towers, and appointment of the game-wardens as fire-wardens.

NOTES ON SAND, STONE AND GRAVEL FOR SALT WATER CEMENT.*

By Harrison S. Taft, Seattle, Washington.

THE success to be attained by placing concrete structures in sea water depends upon, first, the possibility of using cement in salt water, and, second, an economical design. Without doubt a great many prominent engineers hesitate to recommend the placing of concrete structures in sea water more from a chemical point of view perhaps than from a structural one. If the material out of which the structure is to be built cannot be depended upon to maintain its integrity when exposed to the elements, the very best design will not solve the problem.

Therefore, the chemistry and manufacturing side of the cement industry becomes a question of prime and vital importance as regards cement to be used in sea water structures. The next question is that of impermeability; otherwise the concrete might slowly deteriorate under the action of the chemicals in sea water, since perhaps it is impossible to reduce such actions to a negative quantity. In freezing climates this question of impermeability becomes a very serious one, due to the destructive action of alternate freezing and thawing.

Cement.—The first and chief difficulty that has to be overcome in using concrete in sea water is "the peculiar chemical disintegrating action of the magnesium and other sulphate contents of ocean water upon the alumina compounds in the cement," followed "by the abrasive action of the water of the ever-restless sea" upon the chemically affected and softened concrete.

To overcome the chemical action of the sea water upon concrete the Germans have placed upon the market a brand of cement called "iron ore cement," wherein the alumina content of a cement is partly replaced for fluxing purposes by iron which is not affected deleteriously by the magnesium and other sulphates of the salt water; thus inoculating the concrete, as it were, against attack. The world-famed Teil Cement Works does not allow more than 2 per cent. alumina and absolutely no free lime in the cement which they manufacture for use in concrete structures standing in sea water.

Another German product called Puzzolan-Portland Cement, especially devised for use in sea water, has been on the market some 16 to 18 years. This product is a mixture of Portland cement and a natural puzzolan (a volcanic ash), or of a Portland cement and an artificial puzzolan (blast furnace slag of a certain chemical composition), the mixture being 30 to 60 per cent. puzzolan and 50 to 70 per cent. Portland cement.

The chemical action in hardening results in a Puzzolan-Portland hydraulic cement invulnerable to sea water. Although the mixing can be done on the job, it is far preferable to pulverize the two ingredients together in the mill at the cement factory.

A set of extensive tests made by the German government shows higher strength for Puzzolan-Portland cement concrete both in tension and compression than for pure Portland cement concrete. It has also been demonstrated that the former resists salt water far better than the latter. From an economic point of view in producing resistance to the action of sea water a barrel of Puzzolan-Portland cement has been found to be equal to two barrels of pure Portland cement.

From information obtained in regard to these two German cement products, concrete made of them and placed in salt water has been giving the best and most satisfactory results. Thus a vast amount of salt water concrete construction is being carried on in Germany and other foreign countries, due no doubt to their overcoming the action between salt water and the cement.

Though there have been a number of disastrous disintegrations in using American Portland cements in salt water, on the whole American Portland cement seems to have worked quite satisfactorily in sea water.

Such cement "has the power of armoring itself against the action of the magnesium sulphates of the sea water by the formation on its exposed surfaces of a film of lime carbonate." This film appears to serve as an effective protection to the concrete structure in comparatively still waters, but where the waters are greatly agitated this film has no opportunity to form. Hence "the calcium hydrate set free by the decomposition incident to the hardening of the Portland cement is washed away," leaving the concrete structure unprotected against "further inroads of the deleterious chemicals contained in the sea water."

To reduce the question of the chemistry of sea water cement to a more technical form, Mr. J. M. O'Hara, in a report to the Southern Pacific Railway, states: "The magnesium sulphate present in sea water acts upon the calcium hydrate of the cement, forming calcium sulphate, and further, this calcium sulphate combines with the alumina of the cement, forming calcium sulpho-aluminate, which last compound gives rise to the swelling and cracking of the concrete."

Mr. O'Hara also states that though it may seem that a cement in which the alumina has been replaced by iron is desirable, it would be impracticable, however, to replace *all* the alumina in a cement by iron oxide, as "a product resulting from the burning of ferric oxide and calcium carbonate does not possess hydraulic properties." He further says that whereas it seems to be universally accepted by engineers and others that a dense concrete is impermeable to sea water, the results of tests made by him do not seem to bear out this theory, unless the cement used has the inherent qualities to resist the disintegrating action of the sea water.

In discussing the subject of mass concrete in block form for breakwater purposes, William Matthews, a prominent English engineer, says:

"In a tideway, where mass concrete is used, it is of the utmost importance that the relative sizes and proportions of the aggregate should be such as to produce an absolutely watertight material. The infiltration of sea water into green or unset concrete and its subsequent exudation due to tidal action causes the magnesium salts in the sea water to withdraw a portion of the lime of the cement in the form of calcium salts, leaving a deposit of magnesia in its place. It is this magnesia, derived from sea water, either alone or mixed with lime from the cement, which constitutes the white substance deposited in the interstices of porous concrete between high and low water. Concrete so affected possesses but little strength and its failure is only a question of time."

As the result of his research upon the use of cement for sea water purposes, the eminent Dutch chemist, V. I. P. de Blocq van Kuffeler, Hoorn, in a paper read before International Association for Testing Materials, New York, September, 1912, states "that the decomposi-

*From Metallurgical and Chemical Engineering, January, 1914.

tion of the concrete is caused by the salts contained in sea water; the sulphates are the most to be feared owing to their action on the unstable compounds of lime which are formed during the very long period taken by the cement for hardening. Evidently it is during the first part of this period that the action of sea water is the most detrimental, i.e., when the compounds are least stable. Actual experience has confirmed this theory."

He also says that "when such material as trass or puzzolanes are added to the cement, one part of the lime forms compounds with silicates, the other compounds mentioned becoming more stable and the influence of sea water is less to be feared"; that "fine trass increases the impermeability of the mortar"; and "if the concrete has been hardened in a damp atmosphere the influence of the trass is still more marked."

Irrespective of the brand, a cement to be successfully used in salt water must be of the very best quality, of a fine pulverization, and thoroughly analyzed and tested for its chemical properties. Every means should be taken to avoid too much alumina in a cement that is to be used in salt water. The per cent. of alumina should be low, that of silica high. The cement should also be as free as possible from gypsum.

A cement of the slow hardening order should be avoided. Distinction between "setting" and "hardening" of cement should be kept in mind. A slow setting but quick hardening cement is the proper kind to use in salt water.

Not only must the cement manufacturers provide the engineer and the contractor with a cement of the proper chemical constituents, but the concrete made from said cement must be dense in order to fulfil all the requirements of a salt water concrete. This apparently is what the Germans have been doing, and it explains why they are able to get such excellent results in concrete work in Germany as well as in other foreign countries. It is an exceedingly important question for domestic cement manufacturers to consider.

As considerable stress has been laid above on the German method of manufacturing cement for sea water purposes it is fitting to still further consider what Herr Blocq van Kuffeler says upon the question of using cement in concrete placed in salt water. He states that the following points should be most strictly adhered to in using concrete in salt water:

(a) Artificial (slow-setting Portland) cement of first-class quality and hardening very uniformly should be used to the exclusion of all others.

(b) The mixing of the material and the ramming of the concrete in strong and tight casings must be performed with the greatest possible care.

(c) The use of trass (or puzzolanes) is recommended.

(d) The concrete must be compact and the composition of the mortar should not be below 1 part cement, ½ trass and 3 sand, or 1 part cement, 1½ sand.

(e) Allowing the concrete to set in a damp atmosphere before placing "in situ" greatly increases its resistance to attack by sea water and is recommended where possible. When the concrete is exposed to the infiltrations of sea water immediately after manufacturing its composition should be richer.

In conclusion he says a carefully considered composition, most careful manufacture, the use of excellent cement with trass (or puzzolan) and hardening in a damp atmosphere are the most efficient means of satisfactorily ensuing the preservation of reinforced concrete in maritime works.

Laboratory or Similar Tests.—For several years past the United States Government has been carrying on a set of tests at Atlantic City and elsewhere to determine the exact fact as regards the use of cement in sea water. A preliminary report of these tests has recently been issued by the government. Although three years is a comparatively short time for determining the absolute facts under actual conditions, the results of these tests so far published seem to indicate that the success of using concrete in sea water depends in a large degree upon careful and proper working of the material rather than upon the special brand of the cement itself. It is true that some cement works better than others in sea water, those with a low percentage of alumina giving the most satisfactory results, but with an impermeable structure as the prime factor in all cases.

Although these government tests will no doubt in time give the concrete engineer the absolute facts as regards the situation, the engineers of this country already have the actual experience of some 18 years of foreign practice by which to guide themselves. No doubt the final results of these United States government tests will simply substantiate what has already been learned regarding the use of cement in sea water by foreign chemists, viz., an impermeable mass with a low per cent. of alumina in the cement used.

In the early part of 1909 twenty-four test pieces were made of concrete and hung from one of the wharves at the Charlestown Navy Yard, Boston Harbor. These test pieces were 16 feet long, 16 inches square and made with a core for part of their length so as to provide a means of determining their permeability. Several different kinds of cement were used in making these pieces and the concrete mixed in various proportions; some of the pieces being made dense, others porous. These pieces were hung from the pier in such a way as to have their lower ends always in water, while the tops were seldom submerged. At the end of the first two years of immersion one of these test pieces showed marked signs of deterioration, while others were in good condition. Later reports go to substantiate the truism mentioned above, since the pieces made of a porous nature have deteriorated somewhat with those of a dense nature are in the same perfect condition as the day they were made.

Though these laboratory tests will go a long way in revealing the true facts and actual conditions it is necessary to guard against in the use of cement in sea water, "it must ever be kept in mind that the phenomena, both physical and chemical, in the sea cannot be reproduced exactly in laboratories on land." Consequently laboratory tests will never give the real truths of using cement, and hence concrete, in sea water as will actual experience. Thus the actual experience of foreign engineers in the use of concrete in sea water structures and the modes pursued by them are far more valuable to the American engineer than any short time test made in this country.

Admitting that laboratory tests are absolutely necessary and that the world cannot get along without them, such tests must be considered hand in hand with actual experience and as supplementary thereto. The fact that local conditions and local material will seriously alter cases brings home to the engineer the truth that he must not judge foreign experience by home conditions, and vice versa, until the actual conditions covering each are known and is used as the complement of the other.

Waterproofing Compounds.—In view of the claims made by waterproofing experts as respects the excellency of their product, it is proper to quote from an article en-

titled "Test of Water-Proofing Material," U.S. Bureau of Standards, No. 3, August 22, 1911: "Portland cement mortar and concrete can be made practically water-tight or impermeable (as defined below) to any hydrostatic head up to 40 feet, without the use of any so-called 'integral' waterproofing material; but in order to obtain such impermeable mortar or concrete, considerable care should be exercised in selecting good material and aggregate, and proportioning them in such a manner as to obtain a dense mixture. The consistency of the mixture should be wet enough so that it can be puddled, the particles flowing into position without tamping. The mixture should be well spaded against the forms when placed so as to avoid a formation of pockets on the surface.

"The addition of so-called 'integral' waterproofing compounds will not compensate for lean mixtures, nor for poor material, nor for poor workmanship in the fabrication of the concrete. Since in practice the inert integral compounds (acting simply as void filling material or in the nature of a lubricating material) are added in such small quantities, they have little or no effect on the permeability of the concrete. If the same care is taken to make the concrete impermeable, without the addition of waterproofing material, as is ordinarily taken when waterproofing materials are added, an impermeable concrete can be obtained."

In connection with this part of the subject it may not be out of place to speak of "oiled concrete" for waterproofing certain classes of concrete structures. It is of such recent development that sufficient opportunity has not been given to determine its real merits for universal waterproofing purposes especially as regard concrete structures standing in sea water. So far as known there are no records "of any such tests ever having been made" and some chemists have positively stated that it will be impossible to make oiled concrete a success for sea water purposes.

On the other hand, I. Hiroi, a civil engineer of Japan, has stated: "Of more than 12,000 concrete blocks of all sizes and of different compositions, used by the writer in harbor works during the past ten years, there has not been the slightest indication of failure. On the contrary, the protection given by coatings of animal, vegetable and mineral origin to the surfaces of the blocks has rendered them almost impregnable against the incessant action of the sea. The protection thus afforded by nature, which would render a comparatively weak artificial stone, when properly made, as lasting as the natural stone used as its ingredient, is unknown in laboratory experiments."

Sand, Gravel, Stone.—The sand used in concrete placed in sea water must be clean, sharp and free from all foreign material. The stone must also be clean and sound. Gravel, if used, must likewise be clean and of proper size. The chemical composition and mineral structure of the stone, sand and gravel for use in proposed sea water concrete structures, should be known absolutely beyond all doubt. Since it is of great importance that concrete used in sea water should have the maximum density, the mechanical composition of sand and gravel should be known and modified, if necessary, by adding screened material.

For the same reason that an igneous rock or material is far better in the construction of a fireproof concrete structure, it is absolutely necessary in salt water concrete to use aggregates that will not disintegrate or fail when exposed to the elements of the salt water and the action of the sea.

Mr. John R. Freeman has called the attention of engineers to the fact that "here and there are banks of sand and gravel which, upon ordinary inspection, appear ideally perfect for making mortar and concrete, but which are nevertheless dangerous in the extreme, and all because of some ultra-microscopic content, probably similar to tannic acid (in a colloidal film around the sand grain), which works in some mysterious way to prevent the union between the cement and the sand grains."

Mr. Freeman cites an occasion where he found at the site of a proposed structure what promised to be a most economical resource in a shape of excellent sand and gravel; but upon being tested some of the samples of 1:3 mix, six days in water, hardly maintained their integrity while being placed in the clamps and before any load was applied. The cement was of a brand that had given excellent results with other aggregates.

E. E. Free, an investigator, engaged upon physical and chemical investigations for the Bureau of Soils, has noticed analogous phenomena in studying the relative fertility of different soils. Mr. Free states that:

"In popular terms the situation can perhaps best be explained by considering that an extremely thin film of a complex form of tannic acid surrounds each grain of the troublesome sand and prevents its attachment to the cement. These complex organic acids have a strong tendency to spread themselves thinly and strongly adherent over the outside of the siliceous material. The reason why one particular brand of cement is able to break through this filmy barrier so as to get a firm grip upon the sand grain is because of its containing a small quantity of some form of alkali that unites with this acid film or somehow changes its colloidal state."

It is admitted that these defective sands are the exception rather than the rule. Though some engineers and contractors may think the whole investigation a highly interesting laboratory amusement, of no value whatsoever to practical construction, the fact remains that there are sands whose availability for concrete aggregate cannot be predicted under any of the ordinary methods now in vogue, and that ever so often one of these sands gets into a structure to its detriment and perhaps failure if the structure stands in sea water. Therefore the sand and stone should be tested as carefully as the cement for salt water purposes.

Of equal importance is the utmost care that must be taken in mixing and placing the concrete, in order to obtain an impermeable mass throughout. Superintendents and concrete foremen should also be careful to see that injurious acids do not get into the sand, gravel and stone of concrete to be placed in sea water by the working force urinating upon the material. Great care should likewise be taken to exclude from all material entering into the manufacture of concrete such things as scraps from lunches, tobacco and spittle of those chewing tobacco. It is known that an amount of sugar, even as small as ¼ per cent. will entirely prevent a batch of cement from hardening. Since the extract from chewing tobacco contains sugar or glucose, any such extract that enters into the concrete will prevent the cement from setting. There are other organic compounds whose presence in the concrete will have a marked effect on the hardening of the cement, and the utmost means should be taken to exclude such detrimental material from all concrete to be placed in sea water.

Mixture.—In connection with the concrete dock work of the Thames River the practice seems to have been to use "a gravel of moderate size combined with two-thirds of its bulk of sand mixed with one part of cement to every two parts of sand," viz., 1:2:3 mixture. It is stated that with such a mixture there will be no fear of the results if the concrete is properly mixed and handled. The concrete is also given a grout coating after it has set and hardened.

In building concrete breakwaters in Holland it has been found that mass concrete blocks made of 1 part Portland cement, ½ part trass (the trass being a Puzzoland which is found near Andernach on the Rhine), 3 parts sand and 5 parts Rhine gravel, enabled the blocks to resist the corroding action of the sea water. Of more recent date they have been using a cement-trass-concrete of 1 part cement, ⅓ part trass, 2 parts sand and 3⅔ parts gravel.

In Germany a mixture of 1 part cement, ½ part trass, 3 parts sand, 4 parts gravel, is very often used.

During recent years a very rich mixture, viz., 1:1½:3, has been used in nearly all the important sea water concrete structures built in England and France.

In the harbor development of Otaru, Japan, a proportion of 1 part cement to 2 parts sand for the mortar gave superior results; the average concrete mixture used being "1 cement, 2 sand, 2 gravel and 2 broken stone, before the tuff was put in, the ratio equivalent by weight of the cement to the tuff being, 1 cement to ½ tuff." By volume this combination reduces to:

1.0 cement; 0.8 tuff; 3.2 sand; 6.4 ballast.

In the Netherlands Portland cement concrete with the addition of trass has been used almost exclusively. Though Herr Blocq van Kuffeler recommends a mortar of 1 part cement, ½ part trass and 3 parts sand mixture for sea water structures, he states that concrete of the above composition will remain in a perfect state of preservation "provided it has been hardened in a damp atmosphere before placing *in situ*, but is apt to give disappointment if the concrete is exposed to the infiltration of the sea water immediately following manufacture." Under the latter conditions he recommends a richer composition—at least 1 part cement, ½ part trass, 2½ parts sand. When no trass is used he says a mixture of 1 part cement, 1½ parts sand should be used. He also says that whereas mortars of 1 cement, 1½ sand and of 1 cement, 1½ trass, 3 sand can be used with safety in marine concrete work, the latter will create a saving in cost of considerable extent. It is also of great importance that the cement and the trass should be thoroughly mixed before the sand is added.

As respects the use of salt water in the manufacture of concrete, the same eminent chemist states that since the amount of salts introduced into concrete by diffusion when the concrete is exposed to sea water is vastly in excess of any salts that might be introduced into the concrete "by the small quantity of water used in its manufacture—the use of salt water in the making of concrete is in all probability prejudicial to only a slight extent."

As in ordinary reinforcement work, when the reinforcement is complicated, a smaller size gravel should be used with their homogeneity increased, a size of not over .116 cubic inch being recommended by a leading authority for marine reinforced concrete.

Mr. I. W. Sandeman, in his paper upon "Action of Salt Water Upon Concrete," states that for salt water purposes the maximum proportion of the sand in the mortar must not be more than twice that of the cement, and the mortar must exceed the voids in the aggregate. The exact grade of the sand mixed with the cement plays an important part in obtaining impermeable concrete, a hard, coarse sand giving the best results. It was the knowledge of this important point and a thorough investigation of it that enabled the noted Italian engineer, Com. Luigi Luiggi, to construct a dry dock at Bahia Blanca, in 1902, that resulted in a perfectly watertight job. The utmost care was taken in the construction of this dock, with special attention to the bonding of old concrete to the new.

As respects the advantages of using crushed stone over gravel, Mr. Staniford, chief engineer of the New York Dock and Ferry Department, states that his department does not find gravel a suitable material to use in mass concrete when subject to the action of the sea water, and that the broken, hard trap rock, so commonly used in New York City and vicinity, gives far better results in such kinds of concrete than are obtained with gravel. From the author's own experience with broken stone and gravel, he prefers stone, especially if it is trap rock.

Conclusion.—In the final analysis, the successful use of cement in concrete structures standing in sea water boils down to the use of an impermeable concrete made of a cement low in alumina and otherwise suitable for salt water purposes. The former is the problem of the concrete and construction engineer; the latter the problem of the chemist and cement manufacturer. To obtain an impermeable concrete a very rich mixture must be used, the exact proportion between the finer and coarser material being dependent upon the per cent. of voids.

If possible the concrete should be hardened in a damp atmosphere in order to assist the chemical reaction of setting before being placed *in situ*, or before being subject to the action of the sea water, especially so if the sections are small.

The mixing and placing should be closely watched and done with the greatest care, far more so than in the ordinary building work, in order to ensure that each particle of the sand and coarser material is well covered with cement and mortar respectively. A concrete of a medium or plastic consistency will ensure far better results than a wet or dry mixture.

"In the Netherlands experience has furnished conclusive examples as a guide for future construction, with a sufficient degree of safety, as to justify the further application of reinforced concrete in marine structures, which after all are only the work of mortals and not destined to last for eternity."

Mr. W. C. Phelan of the United States Geological Survey, states in a report upon the aluminum industry that the year 1912 was marked by a notable increase in the use of that metal, more than 65,000,000 pounds being consumed, compared with 46,125,000 pounds in the preceding year. Not only was there an increase in the domestic production, but there was a decided growth in the imports [illegible]. The domestic production of bauxite during 1912 was 159,865 long tons, valued at $768,932. Compared with the output in the preceding year, these figures represent an increase in quantity of 4,247 long tons, and in value of $[illegible]. It is significant, however, that the importation of metallic aluminum of different grades increased enormously in 1912, a fact which may possibly account for the small increase in the production and the decrease in the imports of bauxite.

PROTECTION AGAINST FOREST FIRES ALONG CANADIAN RAILWAYS.

SINCE forest protection is the first essential to the development of forestry practice, and since fire has always been the chief enemy of the forest, with the railways as one of the principal agencies responsible for destruction, it is proper to emphasize the remarkable improvement which has taken place in the railway fire situation during the past year. The Commission of Conservation was instrumental in securing legislation which empowered the Board of Railway Commissioners to make regulations for fire protection along the railway lines. Under date of May 22nd, 1912, the Board, by Order No. 16570, covered the railway fire situation very fully, and placed upon the railway companies, subject to the jurisdiction of the Board, the responsibility for taking all measures necessary to the prevention and control of fires due to railway operation. As was reported at the annual meeting of the Commission in January, 1913, the Chief Forester for the Commission was also appointed Chief Fire Inspector for the Board of Railway Commissioners.

During 1912, the railway fire protection work was organized only in the West. In 1913, the organization has so far as possible been extended to the East. As announced by Hon. Clifford Sifton, chairman of the Commission, at the annual meeting in January, 1914, the plan has been consistently followed throughout of building up an inspection staff through co-operation with the existing fire-protective organizations of the Dominion and Provincial Governments, within the territory already covered by the jurisdiction and organization of each. Thus, the Railway Commission has appointed as officers of the Fire Inspection Department, a very considerable number of the officials of the Dominion Forestry Branch, Dominion Parks Branch, British Columbia Forest Branch, Department of Lands, Forest and Mines of Ontario, Forest Protection Branch of Quebec, and Crown Lands Department of New Brunswick. The principal work of these officials for the Board has been in connection with enforcing the requirements as to the patrol work and right-of-way clearing by the railways, though there has been a considerable amount of inspection of fire protective appliances on locomotives, in co-operation with the Operating Department of the Board. It will be seen that in this way the fire-protection work of the Board operates in complete control with the existing fire-protective organizations of the Dominion and Provincial Governments, and all unnecessary duplication is avoided.

In Nova Scotia, the proposed plan of co-operation has not yet been put into effect, pending the appointment of a Provincial Forester, who, according to the law enacted last spring, following the report by Dr. Fernow, on forest conditions in that province, will handle forestry work for the Provincial Government, as well as supervise the work of fire-protection in general.

To handle fire guard inspection in the prairie provinces, plans of co-operation have been developed whereby the Chief Fire Guardian of Alberta and the Fire Commissioner of Saskatchewan have been appointed officers of the Board. As to Manitoba, negotiations are now under way which, it is hoped, will result in a similar arrangement for co-operation by the Fire Commissioner of that Province.

The results which have been secured as a result of the co-operative handling of the railway fire-protection work have been admirable. The occurrence and spread of railway fires has been greatly reduced. The efficiency of the work is in direct ratio to the sufficiency and efficiency of the inspection staff made available by the various co-operating agencies. In the West, practically no criticism could be made on this score. The eastern provinces are somewhat more conservative, and the completion of the organization comes more slowly. However, assurances have already been received which will mean a very much more satisfactory organization in the east during 1914, and, as the work justifies itself by its results, further extensions may confidently be expected. For the most part, the railways have shown a decided appreciation of the work, and have endeavored to comply honestly with the various requirements. There is every reason to believe that henceforth the railways will be found among the minor—instead of the major—agencies responsible for damage by forest fires.

In order to bring this prediction fully into effect, further action is necessary respecting two classes of railways not under the jurisdiction of the Railway Commission. These are the various provincially chartered railways and the Government railways.

As to the first class, action in the form of new legislation is needed in the Provinces of Nova Scotia, New Brunswick and Alberta that railways chartered by these Governments may be required to observe the same precautions that are now required of Dominion chartered lines. These matters have already been taken up with the Governments concerned. In Ontario, existing legislation may possibly be adequate, but there does not seem to be sufficient provision for enforcement.

The situation as to fire protection along the Government railways has shown marked improvement during the past year. Following representations made last spring by the Commission of Conservation and by the Government of New Brunswick, a system of special fire patrols was established along the National Transcontinental Railway between Moncton and Edmundston, N.B., and special instructions were also issued to all employees in regard to reporting and extinguishing fires along the railway line. Much, however, still remains to be done before the system of fire-protection on Government railways will be as intensive as that now required on lines subject to the Railway Commission. Along both the Transcontinental and Intercolonial, there is very much to be done in the way of removing inflammable matter from the right-of-way. This situation is especially serious on the Transcontinental, and will mean a very serious fire risk until the debris is destroyed. It is also necessary that provision be made for special patrols on both lines through forest sections, and that special instructions be issued to all employees, similar to those issued on the New Brunswick Division of the National Transcontinental. Reports also indicate that a closer degree of inspection of fire-protective appliances on locomotives is needed, especially as to those running on portions of the Transcontinental not yet regularly opened for traffic. These various matters have for some time been the subject of discussion between our officers and the Department of Railways and Canals.

The suggestion has now been made to the Minister of Railways that all of the Government Railways should be placed under the operation of the regulations issued by the Board of Railway Commissioners. There can be no doubt that uniform regulations and a uniform inspection would be in the highest degree desirable and would conduce to effective fire-protection. The suggestion is at present under the consideration of the Minister of Railways.

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HIGHWAY SURVEYING.

The attention of our readers is directed to the article entitled "Highways and Highway Surveying," beginning on another page of this issue. The writer, Mr. Hauer, has had numerous requests during the past few years from both young and old engineers to write an article of this nature, whereby any civil engineer in taking up the practice of road work could undertake the special survey work connected with it intelligently and without the necessity of waiting to gain experience that he might deem necessary in order to do it properly.

The subject of road engineering is one of greatest importance in every province in Canada at the present time. Besides the opening of new highways, many communities that have borne expense and inconvenience for years in the upkeep of inadequate roads are awakening to the measure of economy which attends better facilities for transportation. The result is that more attention will be given during the next few years than ever before to the economics and location of country roads and to their construction and maintenance. The advent of motor-driven traffic has precipitated a complexity of shortcomings in previous practice that necessitate placing the care of such roads in the hands of engineers so that the scientific principles involved may be properly applied.

The article referred to has been specially written for *The Canadian Engineer*. The author's broad experience in construction work has equipped him with a knowledge of those details which determine success or failure, and how to achieve the one and evade the other. There is added to this the fact that the first article Mr. Hauer has ever written for any Canadian paper is the one on highway surveying, which he has prepared specially for this journal.

RESPONSIBILITY IN CONTRACT WORK.

Engineers cannot always throw the entire responsibility for the success of the construction of every job upon the shoulders of the contractor. It may be a comparatively easy matter, especially with the assistance of an able solicitor, to prepare a specification by which a municipality runs no risk whatever, but such a specification cannot always be enforced.

To begin with, it is a difficult matter to take away the contractor's right to appeal to the courts, should the specification mean probable confiscation of the work under certain conditions. Even though an iron-bound specification be prepared, such that allows the contractor no resource to the law, and that the engineer is the sole arbitrator of the value of the work done under the specification, the latter cannot always force the acceptance of the terms of the specification. This is especially true where the work is so large that it requires a bonding company's security. If this company believes the specification to be so rigorous as to be unfair to the contractor it will refuse to issue a bond; whereupon the engineer will then have to accept a bid without the bond, or modify his specification to the reasonable wording in which it should have been first written.

A notable case in point is the specification for the Toronto mechanical filtration plant, for which tenders were received a couple of weeks ago. The Department of Works was so anxious to safeguard the city in every possible way that a feeling was created among the bonding companies that the specifications prepared by the Department were entirely too arbitrary. We understand,

unofficially, that as a result not one of the four tenders received was accompanied by the required bond. Moreover, it is believed that some, if not all, of the tenders were submitted with the condition imposed that certain modifications be made in the specifications.

Nothing but praise is due the Toronto Department of Works for its over-anxiety to protect the city's interests; but the case again calls attention to the fact that there are certain kinds of risk in every contract that must be shared by both parties to the contract. Toronto cannot reasonably expect its filtration plant to be an exception to the rule.

THE CONSERVATION COMMISSION AND ITS PUBLIC HEALTH MEASURES.

Several useful publications in the interests of public health were issued during 1913 by the Commission of Conservation under the direction of its medical adviser, Dr. Chas. H. Hodgetts. A compilation of the public health laws of the Dominion, as suggested at the Conference of Health Officers in 1912, a work which was urgently required and which is very much in demand, was one of them. A report was also compiled for the special committee of the House of Commons having under consideration two bills regarding the prevention of pollution of waterways. An illustrated pamphlet was prepared and printed in both English and French, and 150,000 copies distributed, having reference to the collection and disposal of garbage in cities and towns.

The question of sewage disposal as practised in England and Germany has been carefully studied by Dr. Hodgetts, and a report thereon is now in preparation.

Perhaps the most important development in connection with the subject of public health has been the determination of the Commission to take up more actively the question of Housing and Town-Planning. It will be remembered that some attention was given to this subject in the early stages of the Commission's work, and public addresses were delivered with the object of stimulating action by municipalities throughout the Dominion.

Gratifying results have followed from this movement, a great deal of attention having been given to the subject in various places, the most practical work that has been done up to the present time having taken place in the city of Toronto.

At the fifth annual meeting in January last, the chairman announced that with the object of strengthening and advancing the movement in favor of more scientific town-planning and more vigorous attention to the housing requirements of the population, the Commission had determined to act as the host of the National City Planning Conference, which will be held in the City of Toronto this spring. Arrangements are now in progress for the holding of that conference. It is intended, if possible, to make it the means of exciting more direct and effective attention to the subject throughout Canada; and also to procure, if possible, a body of substantive legislation which will enable those who are desirous of promoting progress in this important department of social welfare to act under the sanction of law.

For this purpose there has been appointed a special committee, of which Colonel Jeffrey H. Burland is chairman, having for its duty the preparation of draft legislation. It is the intention to have the recommendations of this committee submitted to the various Governments of the Dominion, and after receiving suggestions from them, to submit the whole matter to a Committee of the National City Planning Conference, with the object of getting a thoroughly digested measure. When this has been done an effort will be made to secure the enactment of the proposed legislation in the different Provinces of Canada.

LETTER TO THE EDITOR.

Billings Bridge, Ottawa, Ont.

Sir,—While appreciating the criticism concerning the floor slab on above bridge given in your issue of February 5th, the writer (the designer of the bridge) would take issue with "Bridge Engineer" as to the strength of this slab.

At the outset, let me say that 4½ in. was the effective depth of slab, the stringers being spaced for roadway at 3½ ft. As the span of slab is less than the width of roller, the roller load of 16,000 lbs. can be reduced to $\frac{3\frac{1}{2}}{4}$ of 16,000 lbs. = 14,000 lbs. This load was assumed to be distributed over an area of 1.16 ft. perpendicular to, and an area of 3.5 sq. ft. parallel to, the axis of the roller. This gives a load of 3,450 lbs. per sq. ft., and is about the worst condition of loading.

This gives a bending moment of 3,500 ft.-pds. using the formula $\frac{w\,l^2}{12}$ for continuous slabs. Dividing this by the moment of resistance of the steel gives the sectional area required per foot of width as 0.6 sq. in.

From this is derived a ratio of reinforcement of about 0.01%, and I fail to see where it is in any way disastrous.

To follow out the motor truck loading as mentioned, let us assume a concentrated load of 8,000 lbs. with a 12-in. wheel base. This will distribute the load over an area equal to 1.16 ft. x 1.83 ft., or 2.12 sq. ft., which gives a concentrated load per foot of width of 3,800 lbs. or, say, 4,000 lbs.

Using the ordinary bending moment formula for concentrated load, $\frac{W\,l}{4}$, gives a moment of 3,500 ft.-pds. and from it is deduced a sectional area per foot of width of 0.6 sq. in., or the same ratio of reinforcement as in the former case and this with a bending moment formula for a simply supported beam.

The figures for the distributing area are obtained in this latter case by assuming an actual wheel contact in a longitudinal direction of 4 in. passing at 45° through the 4-in. wood block and 1-in. sand cushion, and in a transverse direction by the 12-in. wheel base, passing down in the same way.

Expanded metal will be used for reinforcing.

ROBERT HENHAM,
Bridge Engineer.

Ottawa, Ont., February 13, 1914.

ONTARIO GOOD ROADS ASSOCIATION.

The annual convention of the Ontario Good Roads Association will be held in the County Council chambers on Adelaide Street on February 24th, 25th and 26th. The program as arranged provides for the reading and discussion of a number of papers on road construction and maintenance, having particular regard to conditions in Ontario. In view of the highway improvement proposals of the Provincial Government, this is expected to be an important gathering.

SEWER-PIPE AND ROOFING-TILE TESTS OF WESTERN CANADA CLAYS.

THE second part of a report on the clay and shale deposits of Western Canada has just been issued by the Geological Survey, Department of Mines. The first publication covered the results of a reconnaissance, carried out in 1910, of the formations in the region between Winnipeg and the Pacific Coast, which were likely to yield clay or shale deposits that might be of value in the ceramic arts. The report pointed out that there were not only extensive clay and shale formations but that some of them were of excellent quality and adapted to a variety of uses.

The new report deals with more extended investigation of this nature, and presents it on a formational rather than a geographical basis. It covers also the performance of a special series of tests on certain promising clays to determine their value for the manufacture of sewer-pipe and roofing-tile. (In addition, Mr. Keele made a somewhat detailed investigation of the preheating treatment as applied to Western Canada clays. This was outlined in *The Canadian Engineer* for February 12, 1914—page 311.) The sewer-pipe tests were carried out as follows:—

Samples were selected for special tests of those shales or clays which seemed to be of promise for pipe manufacture. These were moulded up to a very plastic mass and then pressed out through an annular die, giving a pipe whose outside diameter was 3 in., and internal diameter 2.5 in. Only those clays were used which flowed smoothly through the die, and these were cut up into 6-in. lengths.

After moulding, the pipes were dried and burned to cone 010, after which they were placed in the kiln of a sewer-pipe works, firing to cone 4.

It was to be expected that all of the samples tested might not yield the best results, as some would no doubt give better glazes when burned at a slightly different cone.

The clays used, together with the results obtained, were as follows:—

No. 1747.—Mixture of two parts Pierre shale from La-Rivière, and one part Niobrara shale from Leary, Man. This took a bright salt glaze, but not an exceptionally smooth one. This was undoubtedly due to the fact that the mixture was not ground fine enough, and that cone 4 is a trifle too high for these clays.

No. 1754.—Fireproofing clay from Coleridge, Alta. The salt glaze on this was fair, but the clay is hardly fire-resisting enough for successful salt glazing, even if its other physical properties were favorable to its use in sewer-pipe manufacture.

No. 1765.—Shale from Tofield, Alta., used in the proportions of 75% raw clay and 25% calcined clay, plus 2% salt to prevent cracking in air drying. This at cone 4 was much overfired, and it is doubtful if it would stand the heat required for salt glazing. If softened so at cone 4, that it was not stiff enough to hold its shape.

No. 1762.—Upper 7 ft. of shale from south bank of Lobstick River near Entwistle, Alta. The salt glaze on this was poor, and the clay itself is hardly refractory enough for making sewer-pipe.

Nos. 1805, 1806, and 1807.—Mixture of equal parts of these three clays, from the Dirt Hills, Sask. This mixture gave excellent results at cone 4. The pipe was straight, nicely vitrified, and the glaze smooth. The mixture should undoubtedly make a good sewer-pipe. The unglazed pieces showed some soluble salts, but not enough to interfere with the salt glaze.

No. 1817.—Mixture of two parts of top shale and one part under clay from Walton's mine, Minto, N.B. This took a good salt glaze, although cone 4 seemed a little too high, and better results would no doubt be obtained at cone 3. Care should be taken to grind this shale fine.

No. 1824.—Shale overlying sandstone, at Stonehaven, N.B. Like the preceding this developed a good salt glaze at cone 4, but was a trifle overfired. Cone 3 would be a better burning temperature for it. The clay should also be finely ground.

Roofing-Tile Tests.—A clay, in order to be useful for roofing-tile, should conform to certain requirements. These might be enumerated as follows: (1) suitable plasticity; (2) moderate shrinkage; (3) sufficient strength; (4) wide vitrification range; (5) development of preferably a red color in burning, which should be maintained without change over a range of several cones; (6) freedom from cracking and twisting in burning; (7) slow and slight warpage if burned unsupported.

It may not be difficult to find a clay which shows the proper development of some of these properties, but materials which are eminently desirable in all respects are more difficult to obtain.

In the manufacture of flat shingle tile and normal Spanish tile these slabs can be made by forcing a ribbon of clay through a slit-like die, and then cutting the ribbon up into proper lengths.

More complicated shapes, such as interlocking tile, are made by forcing a bar of clay through the die of a stiff-mud machine, this bar being then cut up into slabs which are given the proper shape by re-pressing in a plastic or steel mould.

One of the tests that may be applied to a roofing-tile clay in the laboratory, is the warpage test. This consists in moulding the clay or mixture of clays into thin strips 13 in. long, 1¼ in. wide, and ½ in. thick.

These are carefully dried, and then placed in the kiln resting on sharp edged fireclay supports, with a 10-in. span between the edges.

In the experiments these were burned at cones 010, 03, 05, and 1. The names of the clays tested and the results obtained in each case are given below.

In the testing of roofing tiles it has been advocated by some that their transverse strength when air dried should be determined,[1] but as shown by others,[2] the transverse strength of an air-dried clay stands in direct relation to its tensile strength, consequently it seems sufficient in describing these tests to give the latter.

Niobrara Shale from Leary, Man. (1636).—To this was added 25% of grog, consisting of calcined shale, to improve its working qualities. The bars had an average air shrinkage of 5.5%, and dried well without warping. The average tensile strength was 243 pds. per sq. in.

At cone 08 the fire shrinkage was 5.1, the sag 0.35 in., and absorption 12.2%. At cone 05 the fire shrinkage was 6%, the sag 0.58 in., and absorption 10.2%. At cone 1 the clay had sagged so as to give a deflection of 3½ in., and is to be regarded as over-fired. The clay is nearly steel hard at cone 08.

Clay from Dirt Hills, Alta.—This a grey shale lying at base of section in hill No. 2 (1647). The clay bars had an average air shrinkage of 7%, and an average tensile strength of 334 pds. per sq. in. It warped very slightly in drying.

At cone 08 the fire shrinkage was 1%, the sag was 0.08 in., and absorption, 15.5%. At cone 05 the fire

[1] Orton and Worcester, Ohio Geol. Surv.

[2] Ries and Allen, Trans. Amer. Ceram. Soc., vol. XII.

shrinkage was 2%, the sag 0.09 in., and absorption 14.7%. At cone 1 the fire shrinkage was 8%, the sag 1.37 in., and absorption 3.2%. The clay burns light red up to cone 05, but deepens considerably at cone 1.

Shale from Kilgard.—(1738).—The strips of this shale dried perfectly and had an air shrinkage of 4%. The average tensile strength was 114 pds. per sq. in. At cone 08 the fire shrinkage was 0%, the sag 0.08 in., and absorption 22.6%. At cone 05 the fire shrinkage was 1%, the sag 0.09 in., and absorption 17.3%. At cone 1 the fire shrinkage was 6.5%, the sag was 1.14 in., and absorption 7.3%. At cone 3 the fire shrinkage was 7%, the sag 1.57 in., and absorption 9%. The color after burning was a soft drab.

Shale over Coal at Minto, N.B.—(1817).—The shale dried well without warping. Its air shrinkage was 3.5%, and tensile strength 68 pds. per sq. in. At cone 08 the fire shrinkage was 2.5% and sag 0.28 in., with an absorption of 9%. At cone 05 the fire shrinkage was 4.5%, and the sag 0.60 in., with an absorption of 6.2%. The shale burns red, but the color is somewhat dull.

Surface Clay from Merritt, B.C.—With 25% sand added (1779A), the mixture dried without warping and had an air shrinkage of 7.5%, the tensile strength being 318 pds. per sq. in. At cone 08 the fire shrinkage was 9.5%, the sag zero, and absorption 13.2%. At cone 05 the fire shrinkage was 0.5, and the sag still zero, with an absorption of 13.2. The clay burned red but showed a tendency to scum, although this could be prevented.

Mixture of 3 Parts of Grey, Sandy Clay from Camrose, Alta., and 1 Part Shale from Gwynne, Alta.—(1801A).—This clay showed a tendency to buckle in drying, and its air shrinkage was 8%. The tensile strength of the mixture was 166 pds. per sq. in. At cone 08 the fire shrinkage was 0%, the sag 0.13 in., and absorption 17%. At cone 05, fire shrinkage still 0%, sag 0.16 in., and absorption 10.2%. The clay burns to a good red color.

Clay from Brickyard Site, Taber, Alta.—(1791).—This Clay dried without appreciable warping and had an air shrinkage of 8.6%. Its average tensile strength was 135 pds. per sq. in. At cone 08, the fire shrinkage was 2%, the total sag 0.14 in., and absorption 15.4%. At cone 05, the sag was 0.17 in., and the absorption 14.4%.

Lower Shale, South Side of Lobstick River, Near Entwistle.—(1763).—This shale dried well without warping, and had an air shrinkage of 6.0%. The average tensile strength was 114 pds. per sq. in. At cone 08, the shale had a fire shrinkage of 2.5%, a total sag of 0.18 in., and an absorption of 13.6%. At cone 05 the fire shrinkage was 3%, the total sag 0.24 in., and absorption 12%. At cone 1, the fire shrinkage was slightly greater, being 5%, the total sag 2.55 in., and absorption 0%. The shale burns to a light red color at the first two cones but is much darker at cone 1. It became steel hard at cone 05.

Sewer-pipe Shale East of Brickburn, Alta.—(1759).—This shale showed no distortion in drying, and had an air shrinkage of 6%, and the average tensile strength of 60 pds. per sq. in. At cone 08, it had a fire shrinkage of 1%, the total sag 0.09 in., and the absorption 12.3%. At cone 05, its fire shrinkage was 1.5%, total sag 0.16 in., and absorption 11.7%. At cone 1 the fire shrinkage was 6.5%, with a total sag of 1.42 in., and an absorption of 4.5%. The clay was steel hard at this last cone.

Shale from Valley of Bull's Head Creek, Alta.—(1757).—This warped slightly in drying and had an air shrinkage of 7%. Its tensile strength was probably high. At cone 08 the fire shrinkage amounted to 0.5%, with a total sag of 0.12 in., and an absorption of 10%. At cone 05 the fire shrinkage was 0.5%, the maximum sag, 0.18 in., and the absorption 9%. Its absorption at cone 1 was 2%. The clay burns red.

Fireproofing Clay, Coleridge, Alta.—(1754).—In drying this clay showed no tendency to warp. The air shrinkage was 4.6. The average tensile strength was 284 pds. per sq. in. At cone 08 the fire shrinkage was 0%, the total sag 0.06 in., and absorption 15.6%. At cone 05 the fire shrinkage was still 0, the total sag 0.07 in., and absorption 15.5%. At cone 1 it sags still more, but the exact amount was not measured.

Surface Clay from Hazel Brae, Clayburn, B.C.—(1741).—This clay dried well without warping, and had an air shrinkage of 6%. The average tensile strength was probably good, but was not tested. At cone 08 the fire shrinkage was 1%, the sag 0.08 in., and absorption 16%. At cone 05, the fire shrinkage was 1%, the sag 0.13 in., and absorption 16.4%. At cone 1 the clay was past vitrification, and had sagged badly. The clay burns to a good red color at the first two cones.

For convenience of comparison these properties are given in tabulated form in Table I.

Table I.—Summary of Roofing Tile Tests.

				Cone 08.			Cone 05.			Cone 1.			Cone 3.			
Laboratory No	Per cent. water required	Tensile strength pounds per square inch	Per cent. air shrinkage.	Per cent. fire shrinkage.	Sag in inches.	Per cent. absorption.	Per cent. fire shrinkage.	Sag in inches.	Per cent. absorption.	Per cent. fire shrinkage.	Sag in inches.	Per cent. absorption.	Per cent. fire shrinkage.	Sag in inches.	Per cent. absorption.	
1636..	32	243	5.5	5.1	0.35	12.2	6	0.58	10.2	...	3½	...	...	...	...	red
1647..	30	334	7	1	0.08	15.5	2	0.09	14.7	8	1.37	3.2	...	...	...	red
1738..	18	114	4	0	0.08	22	1	0.09	17.3	6.5	1.14	7.3	7	1.57	9	drab
1817..	..	68	3.5	2.5	0.28	9	4.5	0.6	6.2	...	...	...	...	...	...	red
1779A.	..	318	7.5	0.5	0	13.2	0.5	0	13.2	...	...	...	...	...	...	red
1801A.	24	166	8	0	0.13	17	0	0.16	10.2	...	...	...	...	...	...	red
1791..	26	135	8.6	2	0.14	15.4	5.3	0.17	14.4	...	...	...	...	...	...	red
1763..	22	114	6	2.5	0.18	13.6	3	0.24	12	5	2.55	0	...	...	...	red
1759..	18	60	6	1	0.09	12.3	1.5	0.16	11.7	6.5	1.42	4.5	...	...	...	red
1757..	21	—	7	0.5	0.12	10	0.5	0.18	9	...	...	2	...	...	...	red
1754..	20	284	4.6	0	0.06	15.6	0	0.07	15.5	...	...	...	...	...	...	red
1741..	30	—	6	1	0.08	16	1	0.13	16.4	...	...	...	...	...	...	red

RAINFALL, EVAPORATION AND RUNOFF IN MANITOBA.*

TWO main factors enter into the investigation of any possible power development—the head and flow available. While the first of these is obtainable through field survey and a knowledge of the extreme and average stages of river level, yet the second comprises an extensive study of the flow which, dependent on natural conditions, varies not only with the season and year, but also with the topography and character of the drainage area. Primarily all waters carried by rivers come from the rainfall or the melting of snow which has been precipitated during the winter months. Of this rainfall a portion evaporates, a portion enters the soil and is either absorbed by plant growth or by ground flow reaches the rivers or lakes, while the third portion finds its way into streams as surface flow or runoff.

Rainfall.—While the record of the runoff from a drainage area is of first importance in the question of power development, yet the rainfall or precipitation is also of extreme value, in that these latter records, if of a more extensive period than those of the runoff, would indicate the high and low range of flow which might be expected. In a like manner rainfall records in a drainage basin in which no discharge measurements are available can be used for the estimation of the flow based on the rainfall and runoff records of an adjacent area.

Throughout the southern portion of the province of Manitoba, rainfall records have been obtained by the Meteorological Bureau of the Marine and Fisheries Department of Canada, and these records are tabulated for the various stations in Fig. 1.

It is well known that the precipitation not only shows a variation from season to season, but also that a record extending over a short period of years is not sufficient to give the mean annual rainfall, but rather that for this means a period or cycle of long term should be considered. As the stations throughout the province at which long-term records have been obtained are not numerous, it is necessary to carry out some system of compensation for the shorter records of the adjacent stations. As is shown on the curves on Figs. 2 and 3, the records of the rainfall at the long-term stations shown separately for the eastern and western portions of the province have the same general features from period to period. Assuming that the intermediate stations of shorter terms will also range in a like manner from periods of heavy to those of light precipitation in the same years as at the long-term stations, the probable ratio of these short-term records to that of a long-term for the same station, has been based on the ratio of the precipitation at an adjacent long-term station during similar years, to the precipitation of the total period of the long-term station. As shown, the precipitation, together with the duration of the record, are given for various stations throughout the province. The ratio of all short-term records has been computed from the nearest long-term station as tabulated in the table, and a compensated annual mean for the station has been calculated. From these compensated results, the location of lines of equal precipitation has been determined. In the preparation of an isohyetal map of this district it has been necessary to use several records of very short period, but in the main, these records have been found to verify the lines of equal rainfall between the long-term stations.

Evaporation.—Of the tremendous losses due to evaporation from the ground surface very little is known. It is impossible to arrive as such losses by taking the difference between rainfall and runoff, as in this there would also be included the losses due to absorption by the soil and by vegetation, and again the rate of runoff does not depend altogether upon the rainfall. It is known, however, that a variation does occur in the evaporation depending upon many factors in which are comprised atmospheric conditions, geological and topographical features of drainage basin, together with the extent of forestration and vegetation.

Station	Elevation	Duration of Record	Years	Annual Mean Ins.	Long Term Mean Based on Record at	Probable Ratio of Rainfall in Two Periods to Long Term Mean (Per Cent)	Compensated Annual Mean for Term Station
Aimosippi		1905 - 1912	10	20 90	Winnipeg	100	20 9
Asesaippi		1886	1	13 52	Minnedosa	65	18 3
Adelphi		1888 - 1912	1	12 25	Bottineau N.Dak.	86	14·0
Brandon	1176	1885 - 1912	21	17 [illegible]		100	17 2
Birtle	1703	1884	1	25 40	Hillview	130	17 6
Barnardo		1891 - 1905	9	16 80	Hillview	122	13 1
Berens River	710	1908 - 1912	5	2[illegible] 22			
Beausejour		1886 - 1888	3	15 09	Winnipeg	52	22 3
Burnside		1886 - 1890	4	4 95	Stony Mountain	70	9 4
Craigilea		1888	1	15 05	Winnipeg	78	18 4
Channel Island		1890 - 1905	15	17 10	Stony Mountain	73	21 7
Cartwright	1533	1884 - 1912	15	19 82	Bottineau	125	5 3
Clarkleigh		1886 - 1888	3	18·10	Stony Mountain	86	20 6
Carberry	1258	1909 - 1911	3	17 07	Minnedosa	90	18 8
Clandeboye		1884 - 1888	4	16 72	Stony Mountain	72	21 4
Elkhorn		1895 - 1901	4	17 81	Hillview	115	15 1
Emerson		1834 - 1898	3	21 67	Pembina N.Dak.	106	20·4
Eden		1884 - 1887	4	17 4	Minnedosa	74	21 6
Fort Ellice		1885 - 1891	7	15 25	Hillview	99	15 4
Gretna	760	1903 - 1910	8	18 67	Pembina N.Dak.	94	19 8
Girard		1904 - 1905	2	[illegible] 77	Bottineau	93	12 6
Hillview	1400	189[illegible] - 1912	20	20 00	Minnedosa	114	17 2
Minnedosa	690	188[illegible] - [illegible]92	32	17 82		100	17 8
Morden	978	1888 - 1912	17	19 69	Pembina N.Dak.	93	21 1
Norquay	798	1888 - [illegible]92	16	19 00	Winnipeg	85	21 9
Oakbank	740	1886 - 1912	22	21 04		100	21 0
Oakdale Park	740	1905	1	18 48	Minnedosa	110	16 6
Portage la Prairie	850	1884 - 1909	14	17 00	Winnipeg	93	18 2
Pilot Mound	1547	1887 - 1898	4	18 74	Pembina	93	20 1
Rapid City	1[illegible]80	1882 - [illegible]92	5	17 65	Minnedosa	91	18 2
Russell		1884 - 1904	9	13 18	Hillview	89	16 8
St. Albans	1060	1885 - 1912	25	17 66		100	17 7
Swan River		1901 - 1910	4	20 85			
Shell River		1884 - 1890	6	15 37	Minnedosa	89	16 9
Stony Mountain	803	1878 - 1909	22	17 64	Winnipeg	83	20 6
Turtle Mountain	2150	1884 - 1904	2	[illegible] 92	Bottineau	141	12 9
Treherne	1212	1910 - [illegible]912	3	8 28	Winnipeg	93	19 6
Winnipeg	760	1875 - [illegible]912	40	21 55		100	21 6
Kenora (Ont.)		1886 - 1912	9	22 41	[illegible]	93	24 0
Norway House		1896 - 1904	8	18 90			
York Factory		1875 - 1882	3	20 38			
Moosomin (Sask.)		1901 - 1905	3	17 39	Hillview	1[illegible]3	15 1
Saltcoats (Sask.)		1900 - 1903	4	15 69	Hillview	122	12 2
Port Arthur (Ont.)		1886 - 1912	27	23 08			

Fig. 1.—Manitoba Rainfall Records.
(Assumption, 10 in. snow = 1 in. rainfall.)

A more complete study has been made of the evaporation from the water surface of lakes and rivers, the greatest use of such studies being in the investigation of storage and the losses which are likely to occur on such reservoirs through evaporation. That the losses on lake areas are very great and often of greater extent than precipitation is well known.

In connection with the investigation of the waterpowers on the Winnipeg River, and with the view to maximum efficiency in the development of powers thereon, it has been found necessary to consider and investigate

*Extracted from a report on the water powers of Manitoba, prepared by the Department of the Interior, Ottawa, for the Public Utilities Commission of Manitoba.

the possibilities of conserving the flood waters. Accordingly, very complete studies are being made of the storage possibilities of the immense lake areas of the the Lake of the Woods district. These studies have naturally included the securing of data with respect to evaporation, and on May 1st, 1913, an evaporation station, together with numerous instruments for the recording of all atmospheric phenomena which affect the extent of evaporation, was established on the Lake of the Woods in the vicinity of Keewatin, Ont.

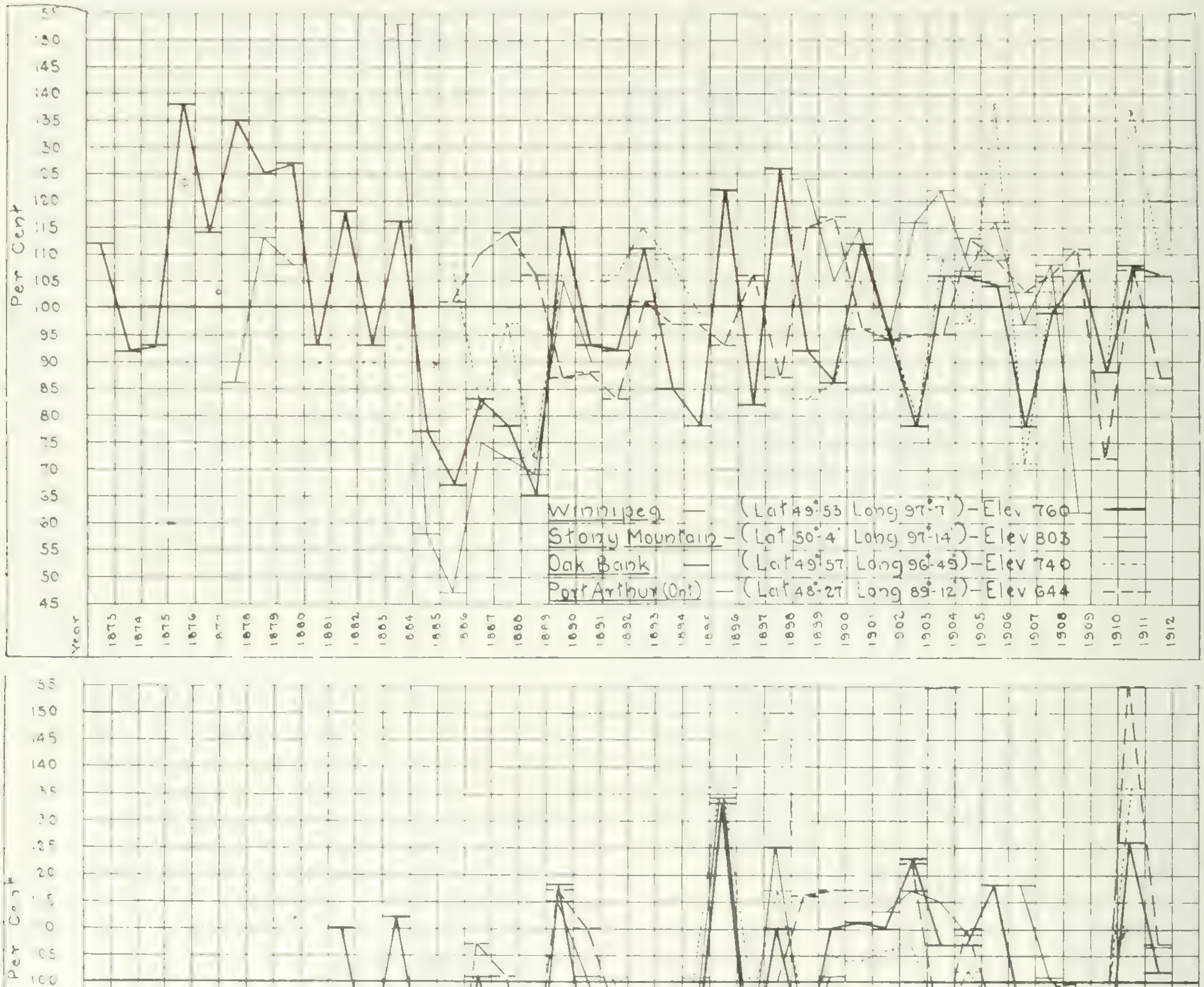


Fig. 2.—Curves Showing Relation of Precipitation at Long-term Stations in Manitoba.

Runoff.—It is readily seen that the extent of runoff or stream flow depends principally upon the depth of rainfall and the area of the basin drained, yet many other factors entering therein and of extreme importance comprise such as the geological formation and topographic features of the drainage area, whether of sloping land tending to give a rapid runoff, or of low-lying, swampy areas from which the flow is more or less uniform, and also dependent upon the extent of the growth of timber and vegetation together with numerous other factors.

While much can be gained from the studies of rainfall and evaporation and the physical features of a drainage area, yet the most accurate and reliable data with regard to runoff or stream flow is obtained by a sys

tematic gauging and metering of the flow of the stream to secure the continuous runoff and extending over sufficient time to obtain the extreme fluctuation. The runoff of any stream varies not only from season to season, but also to such an extent from year to year that the same conditions are not likely to occur on a river on any two successive years. Records for a cycle of at least seven years are, as a rule, necessary to cover the yearly variation to be anticipated.

Not only is the study of the runoff of streams of extreme importance in the investigations of power possibilities, but it is also of extreme value in the investigation of possible reclamation of low lands through drainage, or the reclamation of arid lands through irrigation. Such a study is also necessitated on many rivers where schemes for the betterment of navigation are proposed.

Manitoba Hydrographic Survey.—Previous to the year 1911, there had been no systematic or reliable gathering of data relating to the flow of the rivers in the province of Manitoba. Some few scattered discharge measurements had been made throughout the province, but not of sufficient extent to give information as to the continuous flow of any river as extending over various stages of their discharge. In the above year a systematic study of the power possibilities of the Winnipeg River was inaugurated by Mr. J. B. Challies, Superintendent of Water Power Branch, Department of the Interior of Canada. The field work, of which Mr. D. L. McLean was in charge, consisted of a detailed survey of the river and its power possibilities in Manitoba, and also included the establishment and maintenance of gauging stations on the river. This work, in the spring of 1912, was further enlarged so as to embrace a systematic study of the flow and power possibilities of all rivers throughout the province. For this extensive work, the Manitoba Hydrographic Survey was organized, with the appointment of Mr. D. L. McLean as Chief Engineer, the work still being carried on under the supervision of the Water Power Branch. Numerous gauging stations were established on the rivers and streams throughout the province, and since that time the gathering and compiling of the data has been vigorously carried on.

NORTHERN MANITOBA WATER POWERS.

During the year a report will likely be issued by the Commission of Conservation regarding water-powers in the three prairie provinces of the Dominion. Mr. L. G. Denis, one of the engineers of the Commission, has practically all the data in hand.

During the past year he spent 4 months on a reconnaissance trip through northern Manitoba. From Norway House his party descended the Hayes river to York Factory on Hudson Bay. He then ascended the Nelson river back to Norway House and thence to the mouth of the Berens river, on Lake Winnipeg. This river was investigated to the head of Little Grand rapids, after which the Pigeon river was descended, thereby returning to lake Winnipeg. The Dauphin river was likewise investigated.

The work entailed the taking of levels and discharge measurements, together with notes of the power possibilities along the rivers travelled. This information, added to that which had been previously collected on water-power resources of Saskatchewan, Alberta and southern Manitoba will constitute the substance of the new report.

TEST OF REINFORCED BRICKWORK

By Chas. H. Edmonds,
General Manager, The Reinforced Brickwork Company, Limited, Winnipeg, Man.

A NOTABLE test was conducted at Exhibition Park, Toronto, last fall to determine the maximum uniformly distributed load that could be supported without complete failure:—

1. By a cantilever.
2. By a beam built between two piers.

A solid 9-in. wall was built 3 ft. high, and supported by two brick piers so as to form a simple beam with 10 ft. clear span, and a cantilever beam 5 ft. clear length. The distance from the ground to the bottom of the wall was 3 ft. The two piers were 18 in. square, and were carried on a stone footing 3 x 3 x ½ ft. The vertical joints of every second course of the cantilever brickwork were built right at the pier. The cement mortar was a 3:1 mixture.

The reinforcing used was "HB," as supplied by the Reinforced Brickwork Company, Ltd., Winnipeg, two 2½-in. strips being used per course, (as the wall was 9-in. thick), and was run straight through beam, pier, and cantilever.

The work was allowed to dry out from the date of construction, August 20th, 1913, until October 9th, 1913, during which period the weather was dry and warm.

In order to obtain a uniformly distributed load, pig-iron was piled on the cantilever and beam, care being taken to keep the load built up squarely at the ends, and also to keep the top of the pile level, so that uneven loading conditions might be avoided. The idea followed out was to first load the cantilever to destruction. In order to give a fairly balanced condition, the beam was also loaded at the same time.

The first load was placed on the beam and cantilever on October 9th, 1913, the loading being applied until the beam carried 7,197 lbs., and the cantilever carried 2,519 lbs. On the following day the loading was continued. The following are total loads when work ceased at noon, Oct. 10th:—

Beam, 14,927 lbs.—Deflection, .07 inch.
Cantilever, 6,337 lbs.—Deflection, nil.

When loading was recommenced and had reached 13,063 lbs. the cantilever sheared off at the pier. Outside of a small hair crack on the tension side of the cantilever, and a very slight opening of about half a brick length of a mortar joint, the cantilever was intact. The bricks were broken across, no failure taking place horizontally along the mortar joints at the pier; or in other words, the bricks did not pull out on the tension side, or crush on the compression side of the cantilever. The vertical joints of every second course of the cantilever brickwork were built right at the pier. Had there been no vertical joints immediately at the pier, the ultimate load would undoubtedly have been greater.

Just after the cantilever failed, a slight fracture was noticed on the upper side of the beam. There is no doubt that, because of the cantilever shearing off at the pier, and the whole load falling vertically, the footing of the pier must have been given a severe shock. This, and the sudden releasing of the stress due to the cantilever being continuous, would naturally tend to produce fracture in the beam.

The beam was then further loaded until it was supporting a load of 36,190 lbs., and when this load was reached, it was noticed that the pile, having reached a considerable height, had a tendency to waver sideways. It was felt, in consequence, that further loading would

be carried on under rather dangerous conditions for the workmen. Loading was, therefore, stopped, and seven men were instructed to use a 2 x 12-in. plank, 15 ft. long, as a ram, and to deliver blows on the lower side of the beam at the centre. Seventeen blows were given, the result being a bad fracture, although the beam still held, and showed no inclination to fracture completely. The next blow, aimed at the central portion of the fractured material, caused ultimate failure.

Deflections.—Deflection readings were taken during part of the test. At failure, the cantilever showed a deflection of 0.125 in. The deflection of the beam, loaded with 16,561 lbs., and just after failure of the cantilever, was 0.101 in. Just previous to the load of 18,540 lbs. on the beam, the deflection was .115. At this load, a fracture occurred in the beam as explained above, and deflection readings were discontinued, as the fracture was thought to be more serious than subsequent loading proved.

Similar successful tests have been conducted in Calgary, Vancouver, and Winnipeg, and have a tendency to indicate that a modification of existing ideas with respect to the thickness of brick walls is needed. Building by-laws call for stated thicknesses, but in the cities of Montreal, Winnipeg, and Calgary, it has been conceded that owners and builders should be permitted to take advantage of such improved methods of construction, and the building by-laws have been amended whereby one may reduce the thickness of their walls by 4 in. to 9 in. by the adoption of a proper wire mesh reinforcement. Not only is there a saving of from 10 to 16 per cent. in the first cost, but the builder has the advantage of an additional amount of floor space which is of considerable yearly value to him.

To effectively reinforce a wall, there are certain conditions which must be fulfilled. If a strip of hoop iron is placed in the centre of a joint, and the wall subjected to lateral pressure, the position of the steel coincides with that of the neutral axis of the wall, and the steel will not become stressed. The greatest tension occurs at the outer edge, furtherest from the load, and in this case is carried by the joint—the steel only comes into action when the outer fibres of the mortar joint have failed, and the bond being destroyed, the steel is no longer protected from the weather.

In practice it is found, if using two strips of hoop iron placed near the edge of the wall, that failure will take place by shearing long before the full safe working stress of the steel is reached, partly because there is no connection between the compressive and tensile reinforcements, or no provision for shear, and partly because the metal is not sufficiently surrounded by the mortar to obtain proper adhesion. Consequently, for an effective system there are three fundamental points to be observed:—

(1) The reinforcement must be such that there are sufficient tensional members to take up the tension.

(2) Sufficient members to take up the shear.

(3) Reinforcement must be such that it is completely and easily surrounded by the mortar, both as regards adhesion and protection from weather and moisture.

The action of this new form of reinforcement is as follows:—

The reinforcement is firmly bedded in the mortar joint, and the tensional wires running the entire length and over the joints of support, form a continuous bond, and give to the mortar a power to resist tensional stresses which it does not ordinarily possess. The stresses in a wall, whether lateral or in the form of a load, tend to elongate these tensional members, and this is where the cross or lacing wires come into action. They form, with the tensional wires, a series of triangles which are surrounded and filled with the mortar of the joint. Any tendency towards elongation by the tensional wires would result in a closing action of these triangles, and, consequently, of the mortar inside them, but the mortar, being strong in compression, resists this closing action, and absorbs the stresses of the wire, with the final result that a compound force, much greater than the sum of the individual strengths of both mortar and steel, is developed. Practical tests have shown that the mortar joint is as strong as the brick, and the result is a brick wall which is a monolithic structure, not requiring continuous foundation, and immensely stronger than plain brickwork.

TRANSCONTINENTAL RAILWAY STEAMER FOR ST. LAWRENCE RIVER FERRY.

A CANADIAN car ferry and ice-breaking steamer, built by Cammell Laird, of Birkenhead, for the Transcontinental Railway Company of Canada, was launched on January 17th last. It is intended for service on the River St. Lawrence, between Quebec and Levis, and is a very interesting specimen of naval architecture. Its principal dimensions are, length 326 ft., beam 65 ft., with a draft of about 15 ft. The propelling machinery consists of 2 sets of triple expansion condensing engines, steam being supplied by 8 single-ended cylindrical boilers working under natural draught. An ice propeller of nickel steel, driven by a compound condensing engine, is fitted at the forward end of the vessel, which is built to Lloyds' special survey, and is arranged for the carriage of passenger and freight trains at all seasons of the year.

The trains are carried on a tidal deck, arranged above the main deck of the vessel, on three lengths of track, the length of each track being about 272 ft. The tidal deck rests on castings working up and down on 10 vertical lifting screws on each side, supported on columns, the columns being stayed by lattice buttresses against longitudinal transverse thrusts. The lifting screws are hung on ball bearings from the top, and are manipulated by means of worm-wheels, driven from horizontal shafting, which runs the length of the vessel on each side. The horizontal shafting is worked by bevel gearing from a four-cylinder, high-pressure engine of special design situated below the main deck. The gearing is arranged to lift the tidal deck, fully loaded with a train and locomotive weighing about 1,400 tons, at a rate of one foot per minute, to a height of about 20 ft., which enables the ferry to be loaded or unloaded at any state of tide. At each end of the tidal deck an adjustable hinged gangway is suspended, which allows for any change of trim or heel of ship due to unequal distribution of weights while taking the coaches, etc., on or off the vessel. Above the highest position of carriages on the tidal deck a promenade is arranged all round the vessel, with a bridge platform forward, from which all the operations of steering and manœuvring are directed. The boiler-rooms are arranged in wing compartments amidships, with the coal bunkers and the tidal deck engine-room between them. The main propelling engines are situated abaft the boiler-rooms, and the engine for the ice propeller is placed in the hold just abaft the fore peak bulkhead.

The vessel is fitted with electric light throughout, and electric gear is provided for raising and lowering the end gangways and for hauling the railway carriages on or off. Special arrangements are made for heating the carriages during transit. Double windlasses are fitted, one on each side, with slip-drum for mooring.

CONCRETE IN HIGHWAY WORK.

THE following remarks on the subject of concrete roads were made by Major W. W. Crosby, Chief Engineer of the Maryland Geological and Economic Survey, in the course of a discussion following a paper* read by Mr. Frank F. Rogers, State Highway Commissioner of Michigan, at the Philadelphia convention of the American Road Builders' Association:

While at present there seems to be a sort of a stampede, ably assisted, perhaps, by certain interests, toward the use of concrete for roads and streets, the speaker wishes to utilize this opportunity to express the opinion that the selection of concrete for such work may well be considered as divided into two main questions of great importance for proper determination.

The first of these questions is that of a necessity for rich concrete, or even for a concrete base itself, for the pavement or wearing surface itself—a condition by no means always existing or likely to exist during the life of the wearing surface. Many mistakes, it seems to the speaker, have been, and are being, made by the use of any concrete base or foundation where equal satisfaction at least and great economy would have been had by its omission or the substitution of a cheaper but, under the local conditions, an equally efficient foundation. It is to be understood here that the speaker believes that the use of concrete for the wearing surface itself, except in a few cases under peculiar conditions, is already proved impracticable, but for the sake of brevity the reasons for this conclusion will not be again expressed here.

The second of the questions referred to is made up of the old questions as to (a) the character of the wearing surface to be supplied on top of the concrete base or foundation, and (b) the thickness of such wearing surface.

As to (a) the character of the wearing surface to be built, little need be said at this moment for the purposes of the speaker.

The point which the speaker wishes to make at this time is under (b) the thickness of the wearing surface when the latter is bituminous in composition. Wearing surfaces composed of pitch compounds (bituminous materials, such as asphalts, tars, and oils) mixed either previously or *in situ* with sand, gravel or stone chips, have almost invariably proved unsatisfactory as carpets on concrete unless these carpets have been of more than a minimum thickness, dependent for expression in figures on local conditions, while those of sufficient thickness have proved satisfactory where their construction was proper under all the conditions.

The speaker thinks a reason for this difference in results between carpets identical except in thickness and for the failure of many too thin carpets comes from the fact that the thin carpets do not sufficiently absorb the shocks of traffic to prevent the disintegration and pulverization to a greater or less degree by such shocks of the surface of the concrete to which the carpet is applied. Hence, such carpets, lacking sufficient coherency in themselves and the preservation of a proper surface to which to maintain their adhesion, soon break up and disappear, first in spots and then altogether.

The surface of the concrete base naturally contains a great deal of mortar—an extremely friable substance, readily disintegrated under horses' feet and hard tires. If the effect of these is permitted to pass through the carpet and to reach the mortar, the latter soon becomes broken up and the adhesion of the carpet to a stable surface destroyed.

The same phenomena have been noticed by the speaker in the cases of macadam built of a soft, friable sandstone covered with a thin carpet, and their failure to occur has been equally noticeable where the thickness and character of the carpet has been sufficient to absorb the shocks referred to and to prevent disintegration of the friable materials underneath.

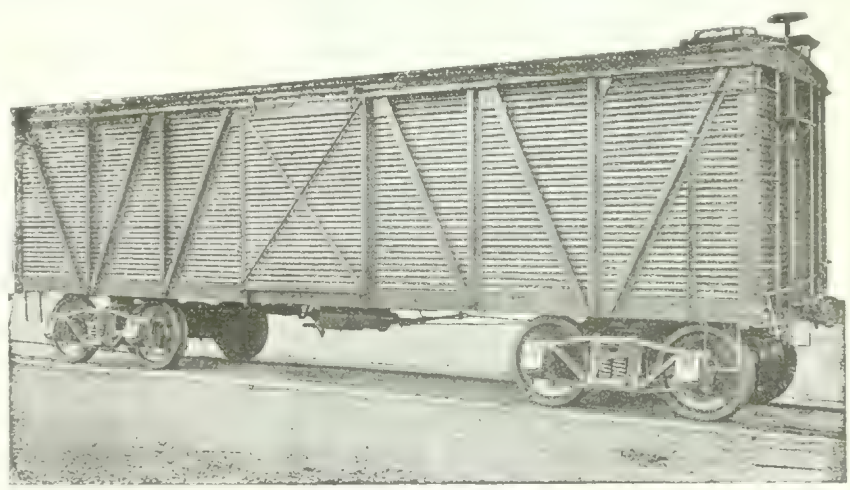
The speaker realizes the difficulties of thick carpets, but he feels they can be solved by proper methods, such as have been used in the case of a familiar form of carpet for city streets—the sheet asphalt pavement. He believes that further solution of the problem of adapting this pavement to country roads—by the substitution of a "paint coat" for the "binder course," for instance—is in sight.

*Published in *The Canadian Engineer* for November 13th, 1913.

ALL-METAL BOX CARS.

The illustration herewith shows an all-metal box car made by the American Car and Foundry Co. at Berwick, Pa., for use on the Central Railroad of Brazil, South America.

Owing to the conditions existing in that section it is necessary to use metal which would be anti-corrosive as the railroad alternates from a high altitude in mountains to very moist condition in the valleys and the extremes of altitude



and temperature are very conducive to corrosion. Toncan metal anti-corrosive sheets were used in corrugated form for the roof sides and ends. It is claimed that such a construction makes a perfectly fire-proof box car and in addition that the majority of methods whereby the car may be broken into and the contents molested are removed. A combination of corrugating and stamping was necessary in order to have the ends of the sheets flat at the corners of the car so that the heavy angle section could be riveted close up, thus preventing any leakage of contents. We are indebted to the Pedlar People of Oshawa, who are the Canadian agents for Toncan metal, for these interesting particulars of a new form of construction.

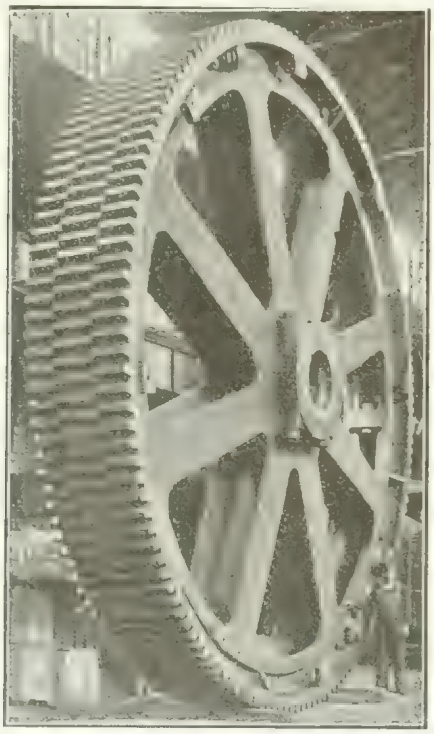
The Newfoundland Railway and Train Ferry Syndicate, Limited, a private company, has recently been granted authority to construct, equip, and operate a line of railway from the south-west arm of Green Bay to Humber Mouth, Bay of Islands.

A GIGANTIC STEEL GEAR.

A steel gear that is very unusual, and probably the largest of its kind ever manufactured, is being installed by the Inland Steel Company, of Chicago, to be used for driving a sheet mill. By the use of this gear and pinion a single-stage speed reduction is obtained from the motor to the mill.

This gear is 22 ft. 8 in. in diameter, with a 38-in. face and 5½-in. circular pitch. The mating pinion is 2 ft. 11 in. in diameter. There are 154 teeth in the gear and 20 teeth in the pinion.

The design varies from ordinary practice, because the teeth are staggered in three sections, as shown in the accompanying figure. On account of the axial motion to which the drive is subjected it was necessary to use a spur gear. Herringbone gears were not considered because of the unequal pressure that would be exerted on the side of the tooth face. The gears travel at the speed of 2,000 ft. per min. To meet the action of this high speed the gears were very



An Unusually Large Triple-staggered Toothed Steel Gear.

carefully cut, the teeth staggered and the drive arranged to run in an oil bath.

The machining of the gear is very interesting. All the teeth of the gear were cut on a planer, specially designed and built by the Mesta Machine Company, Pittsburg, the manufacturers of the gear. For large work they found the old-style crank-operated tools too yielding, and, consequently, originated their own planer. In this machine the tool is driven directly by a heavy lead screw, which in turn is operated by a variable-speed reversing motor.

The gear itself is built up of six parts. The gear centre, including the arms, etc., carries the central rim segments of teeth. The two halves of the gear are bolted together and the separate rims fastened to this by bolts running through the side of the central casting.

Starting with the rough casting, the operation of making such a gear will be followed. After annealing of the casting the joints at the hub and rim of the central portion of the gear were planed. These joints were then drilled, reamed, and the two halves bolted together. The wheel was then placed in the pit lathe, the gear centre turned down to the correct diameter, and the surface machined where the rim segments were to rest. The main gear was then taken from the lathe and the rim segments machined. Lugs were cast on these segments to aid in holding the work on the face-plate. One segment was bolted on the face plate and turned up. It was then reversed and the other side machined to size, and the segment turned to correct diameter. The surface of the segment to rest on the main gear was machined at this time.

The rims were next bolted securely to the main gear centre, with all the teeth in a line across the face of the gear, as shown in Fig. 2. The teeth were then planed, through the centre section and both side sections at the same time. The final cut was taken on the gear without removing the tool during the entire operation of cutting.

The mating pinion was machined in a way similar to that of the large gear. After the teeth were cut the bolts were taken out and the two side sections shifted on the centre section to give the proper stagger. This was done by using an indicating micrometer, so that the slightest variation from exact dimensions could be eliminated. After the stagger of the teeth of the pinion was set, the teeth of the large gear were set to match the pinion.

Holes were then drilled through both rims and the centre of the gear. These holes were reamed and machined bolts inserted.

The gear was then taken apart and shipped. Since the gear is built up of six parts, together with the fact that the parts were fitted together at the plant with machined bolts, before shipping, the installation will be very simple. It will not be necessary to disturb machinery already installed.

UNITED STATES COAL MINING INDUSTRY.

A production between 565,000,000 and 575,000,000 short tons of coal in the United States during 1913 is the official estimate of the United States Geological Survey, an increase over the record-breaking production of 1912 of 30,000,000 to 40,000,000 tons. These figures are given out by Edward W. Parker, coal statistician of the Survey, with the statement, however, that the coal mining industry in 1913 lacked any spectacular features, the increase, in other words, being normal and an index of the general industrial activity of the country. Of this increase about 4,500,000 tons was in the production of anthracite and the rest in the output of the bituminous coal mines.

The coal production in 1912 was 534,466,580 short tons, and the output in 1913 would probably have been somewhat in excess of 575,000,000 tons except for the general shortage of labor in the larger coal-producing states. This deficient labor supply was an important factor, however, in enabling operators to maintain prices, and it prevented an output in excess of market requirements, which would have added one more to numerous preceding years when prices were demoralized by an excessive supply. As it was, there was a slight advance in prices, compared with 1912.

The total coal production in 1900 was 269,684,000 tons.

Experiments described in the *Zeitschift des Vereines deutscher Ingenieure* on the flow of water indicate that a decrease in the flow in ascending pipes, and a low efficiency of certain types of pumps are due to the presence of air bubbles in the water. The velocity of the air bubbles increases with the amount of air flowing, and the relative velocity of the air with respect to the velocity of the water increases with the size of the bubbles.

COAST TO COAST.

London, Ont.—It has been announced that the Toronto-Windsor line of the C.P.R. is not to be double-tracked past London.

Toronto, Ont.—The station of the Marconi Wireless Telegraph Company, recently located at Toronto, is in operation.

New Hamburg, Ont.—The Boards of Trade of New Hamburg and Baden have appointed committees to act for those municipalities in the matter of hydro-radial service.

Winnipeg, Man.—The cash receipts of the Winnipeg light and power department in January will attain a record amount of between $85,000 and $90,000, according to the statement of Manager J. G. Glassco.

Yorkton, Sask.—When the new municipal electric power house is complete, and the two new 500 h.p. Diesel units have been installed, Yorkton's plant will have a capacity of 1,150 h.p. The lighting of the town also is to be extended, its main portion to be lighted by 5-light standards.

Moose Jaw, Sask.—Work on the C.N.R. bridge over the Moose Jaw Creek, the proposed entrance of the railway company into Moose Jaw, has ceased; and it is believed that this entrance will be abandoned in favor of running rights over the G.T.P. track into the city.

Vancouver, B.C.—The Imperial Oil Company has secured about 100 acres on Burrard Inlet, and will expend more than $500,000 in an oil-refining plant. Immediate work is to commence, it is understood. Plans for the improvement of the property include a wharf from 700 to 800 feet long.

Victoria, B.C.—The engineering branch of the Victoria civic service has at present in consideration the proposition of a civic-owned paving plant. The city engineer is securing information relative to cost, etc., pending the decision of the Canadian Mineral Rubber Company in connection with the completion of its paving contracts.

Toronto, Ont.—The recent statement of the Hon. Adam Beck shows construction plans for the Hydro-Electric Commission for 1914 entailing an expenditure of between two and three million dollars, and which, by the end of the year, will make the consumption of power considerably in excess of 80,000 h.p. The present monthly load is close to 55,000 h.p.

Granby, B.C.—During the week ending January 14, Granby smelter treated 22,480 tons of ore, 22,094 tons being from the Granby mines and 386 tons from other properties. The copper shipments amounted to 457,000 pounds. During the two weeks ending December 14, a total of 45,318 tons of ore were smelted and 773,000 pounds of blister copper were shipped.

Winnipeg, Man.—J. P. Gordon, assistant chief engineer for the Hudson Bay Railway, has reported that all the roads have been cut through as far as Manitou Rapids by the sub-contractors, McMillan Bros., and they expect to reach Kelly Rapids, within 100 miles of Nelson, before spring. The embankment of the road has been graded as far as mile 150 north of Le Pas.

Winnipeg, Man.—The construction of a steel bridge across the C.P.R. tracks at Salter Street, Winnipeg, instead of the proposed subway, is a proposal which is gaining favor among civic officials. It is believed that in a few years other passages connecting the north and south sections of the city will be necessary; and a system of bridges is considered preferable to subways, owing to the enormous cost of the latter.

Sarnia, Ont.—It is stated that Sarnia's new waterworks plant on the shore of Lake Huron, just above Point Edward will be completed in July, 1914. It will have a capacity of 6,000,000 gallons daily, and will have cost about $250,000. A feature of the system is that the current of the lake, which runs from 6 to 8 miles an hour at the point at which the plant is located, washes continuously the sand and germs of the filtration basin.

Saskatoon, Sask.—The operating railway mileage in the Province of Saskatchewan at the end of 1913, totalled 4,651 miles, an increase of 897 miles over 1912. This is almost double that of the province of Manitoba, whose railways were extended by 473 miles during 1913. In the Maritime Provinces the increase is merely twelve miles, i.e.:—2 miles in Nova Scotia and 10 miles in Prince Edward Island. New Brunswick remained stationary.

Vancouver, B.C.—The expenditure up to date upon the Point Grey partnership water main from Capilano has exceeded greatly the original estimate of cost. However, that estimate, which was $302,820 for the entire work, was made about five years ago. Up to the end of 1913, there had been expended $379,266 upon the construction; and it is believed that an expenditure of $50,000 will be necessary to complete the work.

Winnipeg, Man.—The gross earnings of the Winnipeg Electric Railway Company for 1913 were $4,078,694, as compared with $3,765,384 in 1912. Net quarterly dividends of $1,070,043, or a rate of 12 per cent. per annum, were paid, leaving a surplus of $185,461 to be added to the profit and loss account. This account at the end of 1913 attained the sum of $2,276,679; and the directors decided to place $1,000,000 of this to the credit of a reserve account; $375,000 in a suspense account; $901,679 remaining in the profit and loss account.

Victoria, B.C.—The award for tenders for piers Nos. 2 and 3, in connection with the Victoria breakwater and harbor works, is being watched for daily by local contractors. The date for reception of tenders was extended to admit of offers from old country firms. Pier No. 2 will be 1,000 feet on one side and 800 feet on the other, and will be 250 feet wide. Pier No. 3, which will be located 300 feet west of pier No. 2, will be 800 feet in length on either side and 250 feet in width.

Toronto, Ont.—A survey for an extension of the Temiskaming and Northern Ontario Railway has finally been made, which is considered feasible by the Provincial Government; and it is expected that construction will commence as early in the spring as the weather will allow. The survey extends from Elk Lake to Gowganda, and will connect by a continuous line of railway Sudbury, Gowganda, and Cochrane. It will make possible the construction of the line at but half the cost involved by the least expensive of the former routes surveyed.

Regina, Sask.—In addition to $160,000, which will be expended on Regina's light and power distribution system in 1914, there is provided $244,000 as capital expenditure on the new power house. Among the larger items which are included in this amount are $72,000 to complete the building, $11,000 to provide for the removal of 1,000 h.p. of boilers from the old power plant to the new, $22,000 for main switchboard and feeder regulator, two 125 k.w. exciters costing $12,000, machine shop equipment costing $6,500, oil filters and storage tanks costing $3,200, and lighting for plant costing $7,000.

St. Thomas, Ont.—The largest steel water structure of its kind has recently been completed at St. Thomas. It is a water tower to be used in connection with the city waterworks system to equalize the pressure and to afford a means

of water supply, should a break occur in the pumps or mains. It forms an integral portion of the improvements at present being carried out at the St. Thomas plant at a total cost of $100,000. The tower itself has been erected at a cost of $25,916, has a capacity of 500,000 gallons, a height of 144 feet, and is not only the largest in Canada, but the second largest in America.

Fredericton, N.B.—The adoption of the Fredericton Gas-light Company's proposition to supply electric power for the lighting of the city streets is likely to be accepted by the civic authorities. The company's proposal is to supply power at 3½ cents per kilowatt hour. The latest figures available show the consumption of current for running the street lighting service to be 105,000 kilowatts per annum, which at the quotation named would make the cost of power about $3,500 per annum. This would mean a considerable saving on the present expense of maintaining a civic plant; and would admit, it is considered, of extending the street lighting service, an improvement urgently needed.

Hamilton, Ont.—The entire plant of the Canada Steel Company, which was partly destroyed by fire in August, 1913, has been reconstructed and is ready for operation. The additions and parts rebuilt, including new machinery, have cost approximately $100,000. The company has erected a new brick and reinforced concrete roll and machine shop, 60 x 120 feet, completely equipped with all necessary tools for doing its own repair work; and a new shipping end to the plant, 60 x 250 feet, with crane runway the entire length, which handles all the finished material directly from the shears into the cars. It has also rebuilt the main mill building, has erected a new power house, installing a new 500 horse-power motor; and also an 8-inch mill.

Victoria, B.C.—Mr. H. E. Beasley, general superintendent of the E. and N. Railway Company, has reported that the Canada Bridge Company has completed the Big Qualicum steel span on the East Coast extension of the railway, and has removed its plant and men to Arbutus Canyon, which overlooks the Saanich Inlet. Since the concrete foundations have been ready for months, and some weeks ago the steel for this bridge was placed in readiness for putting together, it is expected that this structure will soon be erected. The E. and N. line will then have replaced all its timber trestles of any importance between Victoria and Wellington, with steel structures of splendid type.

Port Coquitlam, B.C.—The first ocean-going vessel built on the Fraser or Pitt rivers was successfully launched from the ways of the Coquitlam Shipbuilding and Marine Railway Company at the confluence of those rivers on January 31st. The schooner cost $70,000; and all the lumber which was used, except that of the keel and the spars, was logged off St. Mary's Heights, Coquitlam. She is 216 feet in length over all, with 41 feet beam, 14 feet depth of hold, 17 feet draught of water, 900 tons registered tonnage; and she has a lumber capacity of about 1,000,000 feet. She is iron-kneed and copper-fastened throughout, and all her iron work is galvanized. A shaft tunnel and engine-bed have been provided in case auxiliary engines are installed in the vessel.

Regina, Sask.—While other estimates still remain to be considered, up to date the Utilities and Works Committee of the Regina city council has authorized an expenditure of over $2,000,000 for civic works in 1914. An undertaking of great importance is the construction of a 5,000,000-gallon water storage basin at a cost of $140,000. This will be supplemented by two new pumps which are to be purchased, and together these will insure a water supply of 10,000,000 gallons for ordinary purposes and 10,000,000 gallons for fire purposes. Also this year, 12 miles of water mains and a similar mileage of domestic sewer mains will be laid; while the program of works and estimates also provides for sewage disposal, street railway extensions, construction of pavements and sidewalks, and electric light and power extension.

Fredericton, N.B.—A report has been furnished to the provincial government by Messrs. A. R. Gould and Ross Thompson, of the St. John and Quebec Railway Company, upon the progress made during the winter on the railway's bridge construction. Bridges have been completed at Centreville and Shogomoc; and at present a trestle is being erected at Eel River. From Centreville to Gagetown, all the bridges will have been built before spring, with the exception of one at Pokiok, which is in a small zone where steel is not laid. Material for all the structures is in process of manufacture and will be available as soon as required. The trestles still to be built are three below Fredericton, at Hartt Lake, Swan Creek, and Oromocto; and five above Fredericton, at Kelly's Creek, Long's Creek, Garden Creek, the Meduxuekeag, and the C.P.R. crossing at Woodstock.

New Westminster, B.C.—Mr. J. R. Freeman, consulting engineer for the Dominion Government, furnished recently a report to Mr. J. B. Challis, superintendent of the water power department, upon the Coquitlam dam, which has been built by the Vancouver Power Company, and especially upon the water supply of New Westminster, which is taken from above the dam. Mr. Freeman states that the present and prospective needs of New Westminster for water supply are amply provided for by the new intake tower and by the conduit leading from the tower to a point safely down stream from the limits of the dam; and that the work of the Vancouver Power Company has been of such a nature and scope as to tend to improve the quality of the water conveyed from Coquitlam lake to the city, as a result of the removal of stumps and decaying logs from the swampy margins at the lower end of Coquitlam lake, and also the very thorough work of felling, removing and burning the timber and brush within the range of the increased height of flowage by the new dam. Mr. Freeman concludes his observations on the purity of the water supply in the following words: "I know of no natural surface supply of water in the world that is superior to Coquitlam lake as a source for domestic supply, and I find that the company's work in dam-building has been so carried out as to conserve and improve this excellent quality."

Granby Bay, B.C.—One of the largest smelting plants in the Pacific northwest has been completed by the Granby Smelting Company, which has its headquarters at Grand Forks, B.C. The entire construction includes the smelter hydro-electric power plant, machine shops, and an electric railway system. It is located at Hidden Creek in the wilds of northern British Columbia, and has been erected at an approximate cost of $2,500,000. The purpose of the company, primarily, is to handle the output of its Hidden Creek copper mines, which have at present about 8,000,000 tons of ore in reserve, containing from 3 to 5 per cent. copper; but ores from properties owned by other companies and individuals will also be handled. The Granby Company has recently taken over the Midas group of claims and several other copper properties; but the plant, which will have a daily capacity of 2,000 tons, is expected to handle ore from all of these with facility. Operating expenses, also, will be greatly reduced by the proximity of the mines to the smelter. A connection afforded by 1½ miles of electric railway reduces transportation costs on the ore almost to a minimum. The report on the construction which has been furnished by Superintendent Williams, who is in charge of the construction states that there are 16 inches of snow at Hidden Creek, but that the buildings were all enclosed and roofed before the storms came, making possible completion of the work on schedule, the original estimate providing for blowing in the smelter furnaces between January 1 and February 1, 1914.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice. THE CANADIAN ENGINEER publishes, on page 94, a directory of such societies and their chief officials.

CANADIAN MEMBERS, INTERNATIONAL ELECTRICAL CONGRESS.

In connection with the International Electrical Congress to be held September 15th-18th, 1915, at San Francisco, Cal., U.S.A., during the Panama-Pacific Exposition, the following Canadian engineers have been appointed honorary members of the International committee on Congress organization: Dr. L. A. Herdt, (Vice-President I.E.C. and Local Honorary Secretary), McGill University, Montreal; Mr. Ormond Higman, Ottawa, Ont.; Mr. A. B. Lambe, Ottawa, Ont.; Prof. L. W. Gill, Queen's University, Kingston, Ont.

The proceedings of the International Electrical Congress will be divided into twelve sections, relating to the principal branches of electrical engineering, and it is expected that about 250 papers will be presented covering a wide range of topics. The San Francisco congress of 1915 will be held under the auspices of the American Institute of Electrical Engineers, and is authorized by the International Electrotechnical Commission and the Turin Electrical Congress of 1911. The International Electrotechnical Commission will meet at San Francisco during the week preceding the electrical congress.

TORONTO BRANCH, CAN. SOC. C.E.

The first of a series of monthly luncheons, inaugurated by the Toronto Branch of the Canadian Society of Civil Engineers, was held on February 11th, 1914. Over 75 of the local members were in attendance.

In the absence of Mr. A. F. Stewart, chairman of the branch, Major C. H. Mitchell presided. Among the speakers were Dean Galbraith, Mr. J. M. Clark, K.C., and Prof. C. R. Young.

Mr. Young, on behalf of the library committee of the branch, outlined the plans of that committee for the improvement and extension of the usefulness of the library. It was the ideal of the committee, as it is of the Engineers' Club of Toronto, to bring about a unification of the four separate libraries, now in the Club's rooms, into a large and valuable central technical library, accessible to any one who is a member of at least one of the technical societies contributing to it. Unfortunately, the energies of the Engineers' Club directorate were so much taken up with the problem of securing new quarters at the present time that little could be expected of it in the matter of library improvement for a year or two. However, the Canadian Society of Civil Engineers could do a great deal independently that would in no way interfere with what the Club might do, but would be complementary to it.

The policy of the library committee with respect to immediate extension was, first of all, to put on the shelves bound volumes of indispensable periodicals, especially the proceedings and transactions of the great engineering societies; and, secondly, a selection of the books most useful to the practising engineer. Duplication would, in general, be avoided, but might in a few cases be found desirable. In order to make the best possible choice of books, the opinions of many members of the Branch were being sought.

Several schemes for entending the usefulness of the library were outlined by the speaker. A monthly bulletin was suggested as a means of rousing the interest of the members; the privilege of keeping books out for a limited period appealed to the committee; engineering students in the University of Toronto would find the library of value, and the pointing out of this would be a service to them as well as an advantage to the Society through the incoming of many Student members; and, finally, the obtaining of exchange privileges with libraries in other cities would be a desirable arrangement for the members.

VANCOUVER BRANCH, CAN. SOC. C.E.

As announced in last week's issue, a paper, dealing with the construction of the section of the Canadian Northern transcontinental line between Yellowhead Pass and Vancouver, was read by Mr. J. V. Nimmo, before the Vancouver branch of the Canadian Society of Civil Engineers, on February 3rd. The paper was accompanied by 100 lantern views.

Mr. Nimmo, who has had an extended experience on railway work in India as well as on railway location and construction work in many provinces of the Dominion, dwelt upon his subject with detail, and in explaining the various passes across the several mountain chains and intervening valleys, he showed clearly the advantages attained by the Canadian Northern Railway in its route through the Yellowhead and down to the North Thompson via the Albreda Summit. In his remarks he paid tribute to the sagacity and foresight displayed by Sir Sanford Fleming, whose work in the '70's disclosed the desirability of the Yellowhead Pass. He went into details of grades and other technical features of interest to the engineering profession, indicating what the construction department had to contend with and what the completed railways would have to offer in advantages to the operating department.

Regarding construction, he said that the heaviest work was in the Fraser Canyon, where the heaviest mile cost $326,000, up to the point where it was ready for steel. Other portions of the canyon averaged $252,000 a mile in cost. Four years from the beginning of surveys would see the work completed.

In dealing with the locating and other engineering work, he referred to many of the difficulties encountered, and in the views shown indicated some of the perilous places where the engineers had to work, crawling along the faces of escarpments and overhanging cliffs. Notwithstanding this, only one engineer had lost his life in the work.

AMERICAN ROAD BUILDERS' ASSOCIATION—ANNUAL MEETING.

The annual meeting of the American Road Builders' Association for the election of officers was held at New York, Feb. 6th. At this meeting the following officers were elected:—

President—W. A. McLean, Toronto, Ont.
First Vice-President—Geo. W. Tillson, Brooklyn, N.Y.
Second Vice-President—A. W. Dean, Boston, Mass.
Third Vice-President—A. B. Fletcher, Sacramento, Cal.
Secretary—E. L. Powers, New York, N.Y.
Treasurer—W. W. Crosby, Baltimore, Md.

The following directors were appointed for three years:—

Samuel Hill, Seattle, Wash.; Paul D. Sargent, Augusta, Me.; A. H. Blanchard, New York; R. H. Gillespie, New York; Harold Parker, Worcester, Mass.; Fred. E. Ellis, Peabody, Mass.

The reports of the executive committee and the secretary showed a large gain in the active membership of the Association.

ASSOCIATION OF ONTARIO LAND SURVEYORS.

The following constitutes the list of successful candidates at the recent examinations for Ontario Land Surveyors.

Preliminary—T. N. Enright, Toronto, John F. LaPlant, Simcoe; William W. Perrie, Hamilton; Matthew Rae, Unionville; Henry W. Richardson, Hamilton; Leopold Wright, Toronto.

With supplemental—R. A. Cox, Collingwood; T. K. DeMorest, Ottawa; H. C. Mathers, Lambton Mills; W. R. Peck, Toronto.

Final examination—F. H. Muckleston, Toronto; N. B. MacRostie, Ottawa; S. G. McDougall, Ottawa; G. L. Berkeley, Toronto; Milton E. Crouch, Toronto; Karl Huffman, Toronto; P. A. Jackson, West Toronto; R. S. Kirkup, Fort William.

With supplemental—F. A. Bell, St. Thomas; J. H. McKnight, Simcoe; S. J. Pepler, Toronto; J. M. Riddell, Thessalon; J. R. Wood, Welland.

PERSONAL.

C. H. TOPP has been appointed engineer for the municipality of Esquimalt, B.C., to succeed W. E. Casey, resigned.

E. R. BINGHAM, O.L.S., has been appointed Corporation Surveyor for the city of Port Arthur, to succeed A. L. Russell, resigned.

E. H. VERNER, until recently engineer for the municipality of Coquitlam, B.C., has just been appointed city engineer of Port Coquitlam.

V. J. ELMONT, A. M. Can. Soc. C.E., of Montreal, is attending the annual meeting of the American Concrete Institute and the Cement Show in Chicago.

J. ANTONISEN, C.E., formerly City Engineer of Port Arthur and of Moose Jaw, has tendered his resignation to the Brandon Street Railway Company, for which he has acted as superintendent during the past year.

R. J. MACKENZIE, son of Sir William Mackenzie, will shortly assume the responsibilities of being active head of the lines of the Canadian Northern Railway between Lake Superior and the Pacific coast. He was recently appointed second vice-president.

H. W. DURHAM, M. Am. Soc. C.E., Chief Engineer in charge of highways, Borough of Manhattan, New York City, on February 9th delivered an illustrated lecture on "The Highways of Panama" before the Graduate Students in Highway Engineering at Columbia University.

ROBT. P. WEIR has recently been appointed district representative, with offices in the Traders Bank Building, Toronto, for the Cutter Company, of Philadelphia, Pa. Mr. Weir, a graduate in engineering of the University of Toronto, was previously with the Toronto Power Company, and also with the Toronto Hydro-Electric System.

GEORGE T. CLARK, former City Engineer of Saskatoon from 1909-1913, has been appointed construction manager for Western Pavers, Limited, having purchased considerable stock in the company. He will assume charge on March 1st. Chas. Curtis is president and sales manager of the company and Henry J. Keith is secretary-treasurer.

R. W. MILLS has been appointed head of a new branch of work in the Observatory at Toronto. This service is to supply rural communities with information respecting coming weather and its probable effect on crops, etc. The step was strongly advocated last fall by Mr. R. T. Stupart, Director of the Meteorological Service of Canada. Mr. Mills is a graduate of the University of Toronto.

IRON MINING IN ONTARIO IN 1913.

It has been shown by Mr. Thomas W. Gibson, Deputy Minister of Mines for the Ontario Government, that the production of pig iron in 1913 was about the same as in 1912—e.g., about 600,000 tons, which is valued at about $8,000,000. Five companies operate to produce this tonnage. They are located at Sault Ste. Marie, Midland, Deseronto, Hamilton and Port Colborne. A sixth furnace is being constructed at Parry Sound.

Five mines were worked during the year; the Helen and the Magpie located in the Michipicoten district, and owned by the Lake Superior Corporation; the Moose Mountain, the Bessemer, and the Belmont, the two latter being situated in Eastern Ontario. The ore of the Helen mine is hematite; of the Magpie, siderite, which is roasted to expel the carbonic acid and sulphur; and of the three others, the ore is magnetite, which undergoes concentration and sintering previous to shipment. The ore of the Bessemer is concentrated at Trenton, while the ore of the Belmont is shipped to the new blast furnace recently erected by the Buffalo Union Furnace Co. at Port Colborne. The total output of ore from these mines in 1913 was about 200,000 tons.

BACK COPIES WANTED.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, lacks the following issues: Aug. 13th, 1909; Sept. 17th, 1909; Dec. 10th, 1909; Jan. 25th, 1912, and would be glad to pay 25 cents per copy for any of them. Will subscribers who happen to have these numbers, and who do not care to keep them, kindly send them in to this office in order that they are put into the hands of the party interested?

COMING MEETINGS.

CANADIAN MINING INSTITUTE.—Sixteenth Annual Meeting to be held at Windsor Hotel, Montreal, March 4th, 5th and 6th, 1914. Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

Mr. W. A. McLean of the Highways Department of the Ontario Government has shown in a recent report that, in the organized counties of Ontario, there are 50,000 miles of road. A classification would be approximately as follows:—

Trunks roads connecting the large towns and cities	2,500 miles
County or leading market roads	6,000 miles
(a) Main township roads	25,000 miles
(b) Secondary township roads	16,500 miles

The roads described as trunk roads are, with the exception of a few connecting links, among the most important of the county roads. Main township roads comprise principally the concession roads on which numerous farms front and which converge into and create the traffic of trunk or county roads. Secondary township roads include the little travelled connecting roads.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21283—January 28—Authorizing C.P.R. to construct, by means of a bridge, two tracks of the Cambellford, Lake Ont. and Western Ry. across Sidney Street, town of Trenton, at mileage 87.14 from Glen Tay.

21284—January 29—Relieving, for the present, the C.P.R. from provinding further protection at the crossing known as Keewatin Street, Winnipeg, Man., 400 feet west of mileage 3 on the Brandon Subdivision of said railway.

21285—January 29—Refusing application of G.T.R. for an order amending Order No. 14731, authorizing the G.T.R. to reconstruct Bridge No. 272, mileage 55.75, carrying the 13th Dist., Northern Div. of its railway across a farm road and stream on the west half of Lot No. 20, Con. 3, Tp. Albion, Ont.

21286—Approving revised location of Mount Royal Tunnel and Terminal Co.'s tunnel line from St. Antoine Street to the junction with its main line at Montreal, Que.; and rescinding Order No. 20899, November 27th, 1913.

21287—January 29—Amending Order No. 15440, September 15th, 1911, to provide that the Winnipeg Electric Ry. Co. be authorized to construct its tracks across the C.P.R. spur to the Winnipeg Industrial Exhibition alongside the Winnipeg Beach Branch of the C.P.R. on Selkirk Avenue, Winnipeg.

21288—January 31—Ordering protection by gates at the crossing of Prince Edward Street, by the G.T.R. and C.L.O. and W. Ry. at Brighton, Ont

21289—January 30—Ordering that no car or engine of the G.T.R. be left standing within 50 feet of the east side of the crossing of William Street, London, Ont., by G.T.R.

21290—January 29—Providing protection at the crossing of the first highway east of the station at Hastings by the G.T.R. in the Prov. of Ont.; watchman to be on duty from 7.30 a.m. to 7.30 p.m. daily, to be appointed by G.T.R.

21291—January 29—Authorizing the Municipal Council of the Corporation of Brampton, Ont., to open up Helstine Avenue across the track of the C.P.R. in the town of Brampton, Ont.

21292—January 29—Authorizing the C.P.R. to change the present grade crossing in the Don Road, Lot 2, Con. 3, east of Yonge Street, Tp. York, Ont. and to construct an additional track by means of a grade crossing, across said Don Road, at mileage 93.65, Toronto Subdivision.

21293—January 29—Approving plans No. 55070, December 15th, 1913, and No. 55365, showing overhead highway crossing at mileage 91.7 on the C.L.O. and W. Ry., Tp. Murray, Ont.

21294—January 30—Ordering the C.L.O. and W. Ry. to construct a farm crossing over its railway on the property of Smith A. Hendricks, in Lot 13, Con. 1, Tp. Murray, Ont.

21295—January 31——Extending the time for the completion of the farm crossing on R. V. Ditmars' property by the D.A. Railway, until May 1st, 1914, in the Co. Annapolis and Prov. of N.S.

21296—January 2—Approving location of the Kettle Valley Ry. Co.'s line from Coquihalla Summit to Hope, B.C., mileage 0 to mileage 39.42, subject to the condition that the 14 degree curve at mileage 3.2 be changed to a 12-degree curve.

21297—January 29—Authorizing the C.P.R. to take from the G.T.R. the lands required for right-of-way in the S. ½ of Lot 12, Con. 1, Tp. Hope, Co. Durham, Ont., at mileage 127.74 on the C.P.R.

21298—January 31—Authorizing the C.P.R. to construct a foot bridge over the repair tracks at North Transcona, Man Division.

General Order No. 120—February 3—Amending special tariffs of charges for detention of refrigerator cars when used for shipments of perishable freight, by eliminating the clauses therein relating to detention at the points of loading said cars.

21299—February 3—Authorizing the C.P.R. to re-construct Bridge 91.5, Toronto Subdivision, Ont. Div., Province of Ontario.

21300—February 2—Approving revised location of a portion of C.P.R. main line, Lake Superior Div., White River Subdivision, "as constructed," from mileage 29.00 to mileage 32.69 (Old Line), mileage 29.00 to mileage 32.49 (New Line), through Tps. 37 and 39, Province of Ont.

21301—January 27—Rescinding Order No. 20893, November 25, 1913, and rescinding Order 17358, August 27th, 1912, in so far as it relieves the C.P.R. from erecting and maintaining fences along portions of its right-of-way between Savona and Pennys.

21302—January 30—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway or siding for the Northern Brick Co., from a point on the southwesterly limit of the C.P.R. at mileage 7.42, thence across public highway to and into the premises of the Northern Brick Company, situate in Lot 4, Con. 5, Tp. Waters, Ontario.

21303—January 30—Authorizing the Canada Southern Ry to connect its lines or tracks with the lines or tracks of the Niagara, St. Catharines and Toronto Ry. at the intersection or crossing of said railways near and west of Canada Southern Ry. Co.'s station at Welland, Ont.

21304—January 31—Extending the time within which the siding for the International Harvester Co. be completed, until the 31st May, 1913 by the G.T.R.

21305—January 31—Amending Order No. 20697, dated October 30th, 1913, by adding the following paragraph:—"4.—That the Grand Trunk Railway be, and it is hereby, authorized to construct the tracks of its branch line of railway crossing Gilkinson Street to and into the premises of the International Harvester Company of Canada, Limited (the said branch line having been authorized to be constructed under the said Order No. 19127, dated April 25th, 1913) across the tracks of the Hamilton Street Railway Company at the said point. the crossing to be protected by an interlocking plant, the details of which to be settled by an Engineer of the Board; and the cost of installing and maintaining said interlocking plant to be borne and paid by the G.T.R. Co."

21306, 21307 and 21308—February 2—Authorizing the Hydro-Electric Power Commission to erect transmission line across wires of the C.P.R. Telegraph on West Street, Goderich, Ont.; at Lots 17 and 18, Cons. 4 and 5, Tp. Winchester, Ont.; and on West Street, Goderich, Ont., respectively.

21309—February 2—Rescinding Orders of the Board Nos. 4406 and 5804, dated respectively 27th February, 1908 and 10th December, 1908, and granting G.T.R. leave to terminate lease described therein; and the G.T.R., its servants, agents, and workmen to re-enter and thereafter to have, possess and enjoy the said lands and premises freed and discharged from any further recognition or obeservance of the right, easement and privilege created by the said lease, or by the covenants therein contained.

21310—February 4—Authorizing the C.P.R. to construct, by means of a grade crossing, the tracks of its Ballast Pit Spur at La Fleche, across road allowances between the S.E. ¼ of Sec. 15, and the S.W. ¼ of Sec. 16; the N.E. ¼ 8, and the S.E. ¼ of 15; and the N.W. boundary of Sec. 6, at mileage 137.07 on the C.P.R. Weyburn-Stirling Branch, Sask.

21311—February 2—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway or spur, for the Dominion Grocers, Limited, Moose Jaw, Sask., from a point on the northwesterly limit of right-of-way of C.P.R. main line, Alta. Div., thence across North Railway Street, and across sub-div. Lots 5 to 12 inclusive, Block 67, city of Medicine Hat, Alta.

21312—February 4—Authorizing the C.P.R. to construct the tracks of its Ballast Pit Spur at Meyronne, by means of a grade crossing, across the road allowance between the S.W. ¼ of Sec. 26, and the N.W. ¼ of Sec. 23, Tp. 8, Rge. 7, W. 3 M., at mileage 153.0, C.P.R., Weyburn Stirling Branch.

21313—February 5—Ordering the C.P.R. and G.T.R. to construct a subway under their double main line tracks at or near a point immediately west of the west end of passenger platform of the C.P.R. station at Ste. Anne de Bellevue, Que.

21314—February 4—Authorizing the C.N.R. to reduce its daily passenger service each way, excepting Sunday, to a tri-weekly passenger service each way, between Kindersley, in the Province of Saskatchewan and Hanna in the Prov. of Alta., from the present time until the 1st day of June, 1914.

21315—February 4—Declaring that land applied for by C.P.R. on French River Indian Reserve, Dist. Parry Sound, Ont., is required by Co. for railway purposes and is land which were it property of private owner could be taken without consent of owner.

21316—February 5—Extending until June 30th, 1914, the time within which C.P.R. complete branch line for J. D. Abbott, Balsam Lake, Tp. Eldon, Ont.

21317—February 5—Authorizing C.N.R. to divert public road in S.E. ¼ Sec. 29, Tp. 25, Rge. 20, W. 3 M., Sask., Alsask S.E. line. Rescinding Order No. 17042, July 16th, 1912, insofar as it authorizes crossing of highway between N.E. ¼ Sec. 20 and S.E. ¼ Sec. 29, said Tp.

21318—February 5—Approving and authorizing clearances of G.T.R. sidings serving premises of Canada Forge Co., Limited, Welland, Ont., for a period of six months from date of this Order, subject to provisions that Ry. Co. keep employees off top and sides of cars when operated over said sidings,, and that speed of trains be limited to rate not exceeding three miles an hour.

21319—January 28—Authorizing the C.N.O.R., subject to terms of resolution, to divert Jane Street at station 1094.32 in the town of North Bay, Ont.

21320—February 5—Relieving the C.P.R., for the present, from the speed limitation of ten miles an hour over the crossing of King Street, Virden, Man., subject to certain conditions.

21321—February 6—Authorizing the Toronto Eastern Ry. Co. and the Oshawa Electric Railway Co., to operate their trains and cars, for a period of six months from date of this Order, over the crossing to Carriage Factory, Oshawa, Ont.

21322—February 6—Authorizing the Toronto Eastern Ry. and the Oshawa Electric Ry. to operate their cars and trains over the crossing at Simcoe Street, Oshawa, Ont., for a period of six months from date of this Order.

21323—February 2—Authorizing the C.N.O.R. to construct, maintain and operate spur line of railway from its Montreal-Port Arthur line at the west boundary of the Tp. of Stafford, through the Tp. of Stafford and the town of Pembroke, with two branches at its northerly end in Pembroke, for the service of the Box Factory, the Steel Equipment Co., the Pembroke Lumber Co. and the local freight of the town and surrounding country; and to cross certain streets in Pembroke with the said spur line of railway.

21324—February 7—Authorizing B. C. Electric Ry. to operate cars and trains over crossing of Esquimalt and Nanaimo Ry. near Russell, B.C., authorized under Order No. 18733, February 18th, 1913.

21325—February 10—Rescinding Order No. 21286, January 29th, 1914. And amending Order No. 20899, November 27th, 1913, by adding clause:—"2. That approval herein granted be subject to condition that Applicant Co. acquire fee in and take all land of Mrs. H. B. Rainville, a property owner affected."

21326—February 10—Suspending, pending investigation by Board, Supplements Nos. 151 and 152 to G.T.R. tariff, C.R.C. No. E. 2552, published to take effect February 15th and 16th, respectively.

21327—February 10th—Suspending, pending investigation by Board, advanced rates published in Supplements Nos. 40 and 42 to C.P.R. tariff C.R.C. No. E. 2559, applying on building brick from Cooksville and Weston, Ont., to Toronto; and on gravel and building sand from Cooksville, Ont., to North Toronto, Parkdale and Toronto.

21328—February 10—Authorizing C.P.R. to construct spur for Winnipeg Paint and Glass Co., Limited, in D.G.S. 14, parish of Kildonan, Manitoba.

21329—February 6—Suspending, pending hearing and determination of matter by Board, increases in switching rates on sand, gravel and brick as from February 15th, 1914, notice of which is given in Supplements Nos. 19 and 20 to G.T.R. tariff C.R.C. No. E. 2677.

21330—February 9—Relieving C.P.R. from speed limitation of 15 miles an hour over portions of Weyburn-Stirling branch between mileages 0 and 52.2 on said branch line.

21331—February 9—Authorizing C.P.R. to construct spur extension for Ontario Stone Corporation, Limited, from end of existing spur for distance of 500 feet from B to C, as shown on plan, in Lot 10, Con. 4, Tp. North Orillia, Co. Simcoe, Ontario, at Uhtoff, mileage 68.4 on Ontario Division.

21332—February 4—Authorizing C.P.R. to take certain lands in Con. 3, Tp. Bathurst, Ont., for purposes of its railway, subject to certain conditions.

21333—February 9—Authorizing C.N.O.R. to construct across C.P.R. (Ottawa-Prescott Branch), near Hurdman's Bridge, Tp. Nepean, Ont., subject to and upon certain conditions.

21334—February 10—Rescinding Order No. 17477, September 12th, 1912, and 2. Directing that C.P.R., at its own expense, close present crossing and restore original crossing of Toronto and Sydenham Road, Tp. Holland, Ont., crossing to be constructed as nearly as practicable at right angles as shown in red on plan dated January 23rd, 1914.

21335—February 10—Authorizing C.P.R. to construct, by means of a bridge, across road allowance between Lots 22 and 23, Con. "A.," Tp. Hamilton, Co. Northumberland, Ont., at mileage 121.29 from Glen Tay.

21336—February 10—Authorizing C.P.R. to change present grade crossing in road allowance between Lots 13 and 14, Con. 3, in Tp. Trafalgar, Co. Halton, Ont., and to construct an additional track, by means of grade crossing, across said road allowance between Lots 13 and 14, mileage 31.77, London Subdivision, Ontario Division.

21337—January 29—Authorizing C.P.R. to construct, at grade, tracks of St. Mary's and Western Ontario Ry., along Thames Avenue, and across Park and Elgin Streets, town of St. Marys.

21338—February 10—Approving location C.P.R. station at Parsons, B.C., in S.E. ¼, Sec. 30-24-19, W. 5 M., mileage 22.80.

21339—December 3—Authorizing C.N.R. to construct spur for Dominion Gypsum Co. in Lot 13, River Lot 42, St. James, and to construct said spur across St. James Street, city of Winnipeg, Man., subject to and upon certain conditions.

21340—February 11—Relieving C.P.R. from speed limitation of 15 miles an hour over portion of Swift Current southeasterly branch line from point on main line near Swift Current, Sask., to Neville, Sask., mileage 27.5.

21341—February 10—Authorizing C.P.R. to construct, at grade, its Weyburn-Stirling Branch Line across twenty-two (22) highways, between mileages 277.78 and 298.07, province of Saskatchewan.

21342—February 11—Authorizing G.T.R. to reconstruct Bridge No. 240, carrying its railway over Bear Creek at Mile Post 212.07, near Powassan, 12th District.

21343—February 9—Authorizing C.N.R. to construct spur for Messrs. Nicholson and Blain, to serve Lot 112, Block 7, Hudson Bay Reserve, Edmonton, Alta., and to cross with such spur Peace Avenue, said city.

21344—February 11—Amending Order No. 20857, November 19th, 1913, to provide that G.T.P. Ry., construct forthwith a station and platform at Telkwa, B.C., not to be below the standard of a No. 1 A, B.R.C. station.

21345—February 11—Authorizing C.P.R. to reconstruct Bridge No. 18.71, Coronation Northwesterly Branch, over Battle River, Alta.

21346—February 11—Authorizing G.T.R. to reconstruct Bridge No. 234 over McCormick's Creek, mileage 43.30 on Fourth District, Montreal Division, Province of Quebec.

21347—February 10—Approving Supplement No. 3 to Express Classification for Canada No. 3, prescribing regulations for shipping of live poultry in coops.

21348—February 12—Authorizing the C.N.R. to open for the carriage of traffic its line of railway from Drumheller, mileage 314.7 to mileage 396.4, Alta.

21349—February 11—Ordering the Wabash Railroad Co. to stop its train No. 5 at Corinth, if flagged, on Tuesday, Thursday and Saturday of each week, for a period of 60 days from date of this Order.

21350—February 11—Ordering protection at the crossing of Bennett Avenue, Maisonneuve, by the C.N.Q. and the Montreal Terminal Rys., by means of a pair of gates, which are to be operated by day and night watchmen.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

REPAIR OF INTAKE PIPE FOR CITY OF OTTAWA

RECLAIMING 40-INCH STEEL PIPE LINE LAID A QUARTER OF A CENTURY AGO IN THE OTTAWA RIVER—DESCRIPTION OF REMOVAL, REPAIR AND RELAYING.

By L. McLAREN HUNTER, A.M.I.C.E.,
City Engineer's Office, Ottawa.

At the present time, when Ottawa is in the throes of a discussion of the pure water question, a short description, with illustrations, of the reclamation of the old 40-in. steel intake pipe in the Ottawa River might prove of interest. This pipe, which has lain in the bed of the river for approximately a quarter of a century, has been disconnected, raised, towed ashore, repaired and is now being relaid.

Fig. 1.—A Length of Pipe Ready for Relaying

The work was in two sections, the first of which was from the main pumping station to the shore of Nepean Bay, a distance of over 2,000 ft., and the second from that point across Nepean Bay and the Ottawa River to Lemieux Island, a distance of approximately 3,200 ft.

The first section presented comparatively few difficulties, as the pipe had been laid in an open aqueduct. This was emptied, after having been closed, by means of a coffer-dam at the one end and stop logs at the other. The pipe was then disconnected and each length of about 45 ft. was tested. The old cast iron flanges were then cut off and the rivets and seams caulked where necessary.

After this had been done the pipes were placed in the desired alignment and riveted together by means of steel sleeves so as to form one continuous pipe from the pump-house to Nepean Bay. Two cast steel manholes were placed on this section, to give access to the pipe, if necessary.

In order to overcome the buoyancy which such pipes, when empty, have in water, a series of arched reinforced concrete beams were placed at approximately 25 ft. centres.

At the river end of the aqueduct the old stop-log house, found to be in a dangerous condition, is being replaced.

On the river section more difficulties have been encountered. The first step was to raise the pipes, which

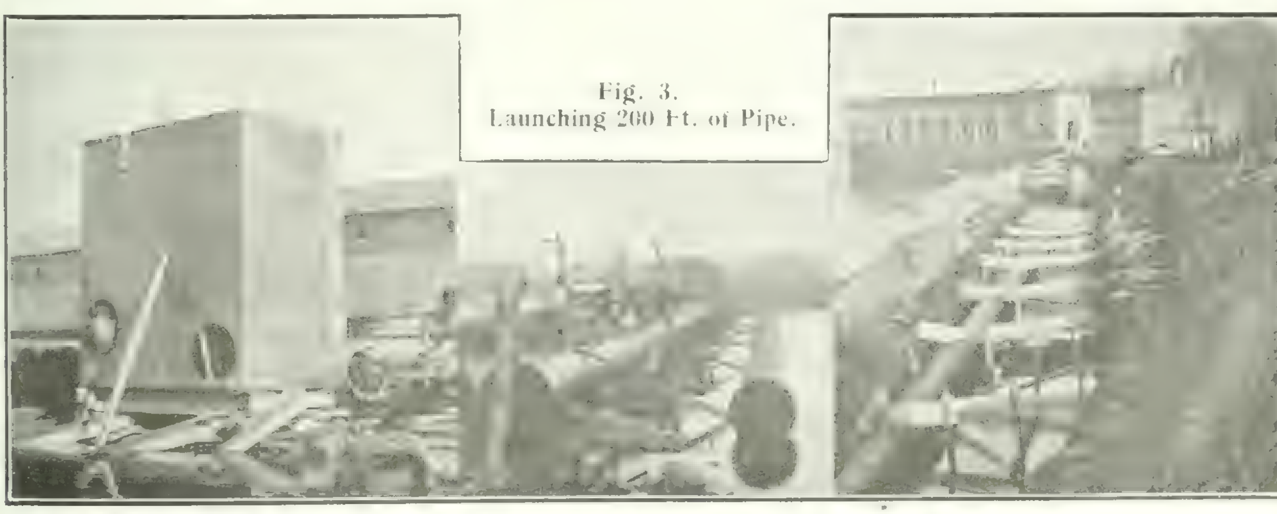

Fig. 3.
Launching 200 Ft. of Pipe.

Fig. 2.
No. 4 Tank on Shore.

Fig. 4.
Pump House and Portion of Aqueduct

averaged 50 ft. in length. They were covered with bark and logs (from the lumber mills nearby) to a depth of 3 or 4 ft. Owing to inaccessibility it was found impossible to secure the ordinary floats or scows for lifting

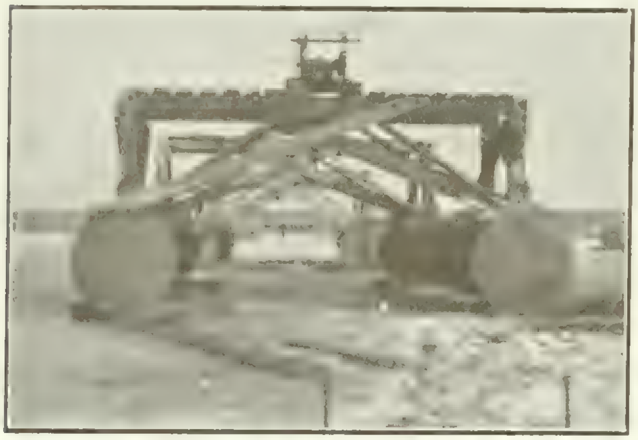

Fig. 5.—The Form of Pipe Float Used.

and taking the pipe ashore. The device used to overcome this difficulty was that of putting bulkheads on two lengths of pipe and erecting a gantry frame at either end, fitted with windlasses. This formed the pontoon

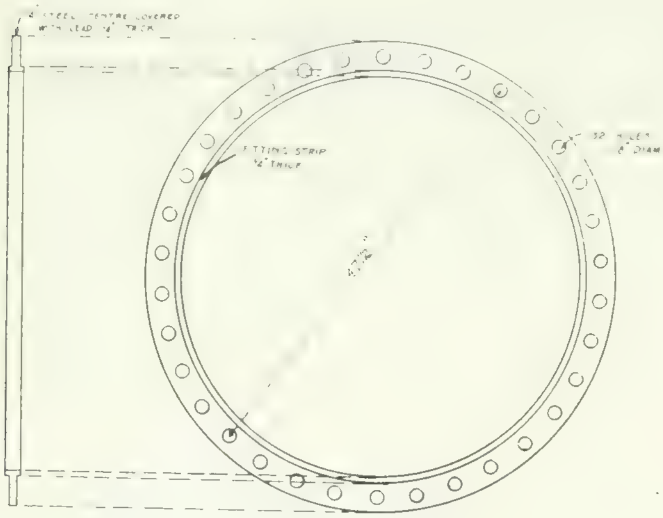

Fig. 6.—Style of Gasket.

illustrated in Fig. 5, 40 ft. in length, 15 ft. wide, with an open space between the pipes of 6 ft. It had a lifting capacity of approximately 13 tons.

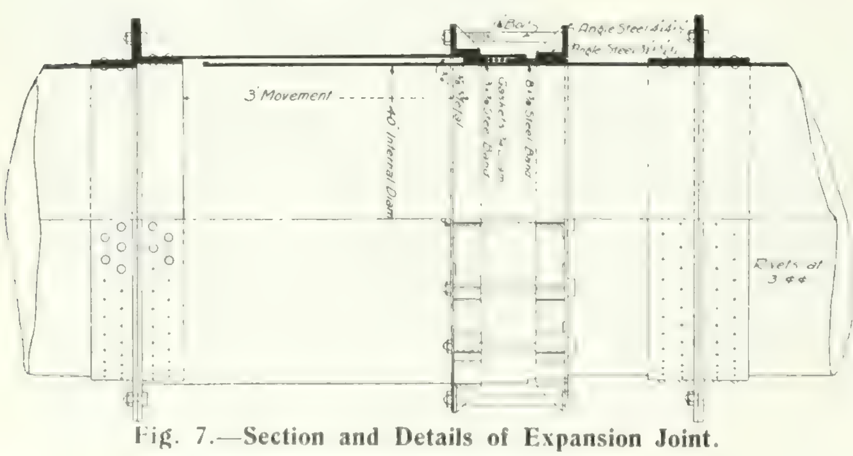

Fig. 7.—Section and Details of Expansion Joint.

This was then floated out over the old pipe, and divers disconnected the sections and placed a chain around either end. The pipes were then raised by the windlasses, emptied of water and a bulkhead put on each

Fig. 8.—Dredging Anchor Ice.

end. They were floated ashore to a temporary repairing yard and repairs similar to those in the aqueduct were effected.

Four of these pipes were connected together by means of alternate plain and special flexible corrugated slews giving an approximate length of 200 feet. (See Fig. 1.) Then curved flanges were riveted on each end

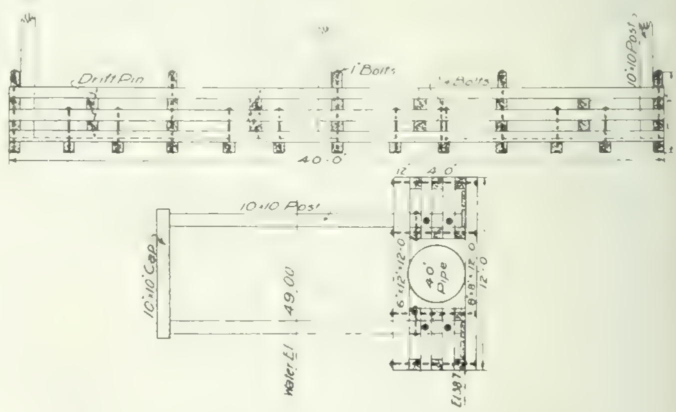

Fig. 9.—Form of Crib for Anchoring Pipes.

and the pipes tested to a pressure equal to twice the working head. All caulking and riveting was done by means of compressed air.

In the old pipe cast iron ball joints were used, but, not being found satisfactory, have been discarded altogether, and special angle pieces are being used instead.

There are 4 new piers being placed on the new pipe line, fitted with sluices. From piers Nos. 1 and 3 arrangements have been made to have cross connections between the 40- and 42-in. pipes. In the case of any accident one section of the pipe can thus be shut off while the remaining sections will be in commission. Pier No. 4, shown in Fig. 2 while under construction, from which there are four connections, was made up on shore before floating out and sinking into position. This necessitated breaking into the 42-in. pipe, a length of which was

lifted, cut to the proper length by the oxo-acetylene method, and then sunk and connected up. All such connections were made under water by divers. A slip joint fitted with graphite packing with a lead ring gasket was used in each connection. The type is illustrated in Fig. 6.

A special expansion joint with a free movement of 3 ft. is fixed on each section in the river. This will allow for any expansion or contraction, and will also be of great assistance at the pier connection. A section and detail drawing of this joint is shown in Fig. 7.

The new line is made so as to present an arch effect against the current in the river, thus relieving, as far as possible, the strain caused by anchor ice, etc.

Considering the length of time these pipes were in the river, their condition was marked, in that there was practically no corrosion. The buoyancy of the pipes in the river was overcome by means of wooden cribs, loaded with stone. Their general construction is illustrated in Fig. 9.

The work is being done by the Montreal firm of Loomis, McBean and Williams, at the contract price of $40,000, but with the extra work which has since been ordered this amount will be augmented by several thousand dollars.

The design and ideas of construction are those of Mr. Arch. Currie, city engineer of Ottawa, who recommended last July that the above procedure be undertaken, while Mr. A. N. Beer, assistant waterworks engineer, and Mr. Peter Carnochan are supervising the work of construction.

POWER DEVELOPMENT AT LONG LAKE, ALASKA.

LONG LAKE, which lies about two miles from the beach at an elevation of 727 ft., has an area of 3.1 square miles. It is situated near Speel River, between Ketchikan and Skagway, 35 miles southeast of Juneau, Alaska. A description of a project on foot to construct a 10,000-kw. plant appears in a recent issue of Western Engineering. Mr. E. P. Kennedy, assistant superintendent, Alaska Treadwell, G. M. Co., is the writer.

Water measurements for eight months and an estimate for the remaining four give a yearly run-off of 21,757 million cubic feet, and as the drainage area is taken at 32.4 square miles, the above run-off amounts to 24 ft., or an equalized yearly flow of 689 cu. ft. per second. The initial plant will use 300 sec.-ft., which is equivalent to a run-off of 10.4 ft. over an area of 32.4 square miles.

The power plant is to be situated near Second Lake, 2,000 ft. from and 535 ft. below Long Lake, and about 1½ miles from the beach. This plant will consist of two units, each of 5,000-kw. capacity and each to be direct connected to a water turbine utilizing 300 second-feet.

To be assured of a continuous flow of 300 sec.-ft., the lake will be drawn on by tapping with a tunnel or by a syphon to a depth of 12 ft., and the two spillways from the lake closed, thus raising the lake level 25 ft., giving an available storage of 37 ft. The cost of this power installation would be:

Power house with two 5,000-kw. units complete	$250,000
Pipe lines, two 60-inch with head-gates	93,594
Closing spillways from lake	10,000
Tapping lake	5,000
Contingencies and incidentals	3,000
Plant for construction	13,882
Total	$375,476

Or a capital cost of $37.54 per kilowatt or $27.95 per horse-power.

The cost of operating the above plant would be, per year:—

General expense	$ 6,000
Operating labor	6,000
Supplies, etc.	4,000
Total	$16,000
Operating cost per year per kilowatt	$1.60
Interest and depreciation, 8% on capital cost	3.00
Cost of kilowatt-year	4.60
Cost of horse-power-year	3.43

To be assured of a yearly average of 10,000 kw., the generators should be run at 25% above normal capacity for 6 months of the year while there is a large excess of water, and thus provide for unforeseen shut-downs.

Surveyed lake area is 3.1 square miles, or 86,423,040 sq. ft., requiring 20 ft. in depth at this area to provide for the required storage.

This storage is obtained by raising the lake level 25 ft. and drawing on the lake 12 ft. The increased area obtained by raising the lake will make up for the decreased area by drawing the lake and also provide sufficient storage below the 2 ft. of ice.

Power estimate is based on a pipe-line loss of 1%, water-wheel efficiency of 82%, generator efficiency of 93%; total efficiency of 75% from the water. Three hundred second-feet under 542-ft. head at 75% will generate 10,320 kilowatts.

From flow measurements the following figures are obtained:—

	Measured flow.	Required flow for 300 sec.-ft.	From storage.
January	324,187,200	803,520,000	479,332,800
February	283,046,400	725,760,000	442,713,600
March	374,976,000	803,520,000	424,544,000
April	352,512,000	777,600,000	425,088,000
May	1,154.390,400	803.520.000	....
June	2,947,104,000	777,600,000	....
July	5,340,729,600	803,520,000	....
August	4,860,492,480	803,520,000	....
September	4.473.792,000	777.600,000	....
October	803,520,000	803.520,000	....
November	518,400,000	777,600,000	259,200,000
December	324,187,200	803,520,000	479,331,800
	21,757,337,280	9,400,800,000	2,510,210,200

Detail of Construction Plant.

Horse tram from beach, 11,000 ft., 30-in. gauge, 20-lb. T-rail, 76 tons at $40 per ton	$3,040	
7,335 ties, 6 by 8 by 48 in., equivalent to 117,328 ft. B.M., at $14 per M.	1,642	
Labor and tools	3,000	
		$ 7,682
Gasoline tow-boat		2,000
2 barges at $3,000		6,000
1 donkey engine		1,400
2 horses		600
1 air-hoist		200
1 compressor with water-wheel and pipe for riveting		2,000
Riveting hammers, etc.		1,000
Camp		2,000
Three cottages		3,000
Sawmill $600, cost absorbed in tram ties and cottages.		
Total cost of plant		$25,882

Allowance for plant after 6 months 12,000
Charged to power installation 13,882

Detail of Pipe-Line for Long Lake 60-in. I.D.

Feet.	U.S. gauge.	Thickness, inches.	Safe lead.	Safe pressure.	Weight per ft.	Total weight.
500....	3/16	0.178	139	60	150.25	75,125
166....	1/4	0.250	185	80	197.50	32,785
166....	5/16	0.312	231	100	244.00	40,504
166....	3/8	0.375	277	120	291.25	48,347
166....	7/16	0.437	323	140	337.75	56,066
170....	1/2	0.300	370	160	385.00	65,450
331....	5/8	0.825	462	200	478.75	158,466
355....	3/4	0.750	555	240	572.50	191,787
Total						666,530

Velocity when carrying 300 sec.-ft., 8 ft. per second; loss per 100 ft., 0.225.

Weight of two lines, 1,337,060 lb.; and estimated cost erected is 7c. per pound.

The steel of which the above pipe is made will have an ultimate tensile strength of 60,000 lb. per square inch. Thickness of pipe is figured from the formula:

$$\frac{\text{Diam. in inches} \times \text{pounds pressure}}{2 \times 10{,}000}$$

which takes care of the efficiency of joints and allows a sufficient factor of safety. The weight of above pipe is obtained from the formula: weight in pounds per foot (12.5 times diameter in inches times thickness in inches) plus 10 lb. This weight takes care of laps, rivets, asphaltum, paint, etc.

RECLAMATION PROJECT IN CHINA.

It has been announced that the Chinese Government has authorized the issue of $20,000,000 of bonds for the future prevention of floods in the Huai River Valley in China, and that the J. G. White Engineering Corporation has been designated to undertake the construction of the works.

The project will require approximately six years to complete, and employment will be given to about 100,000 men. It will involve dredging the channel of the river and the Grand Canal; constructing dams and reservoirs to keep the Huai in its proper course, and to impound its surplus water and divert the streams flowing into the Huai, which, at the time of floods, greatly increase its overflow. The Huai River, for the greater part of its length, flows between banks that are elevated above the surrounding country, and in times past the river in overflowing its banks, has changed the geography of an entire province over night. During one of the flood periods, the Yellow River, which is a tributary to the Huai, switched the location of its mouth a distance of about 700 miles. Government records show that floods in this district have reduced the average number of crops from two in one year to two in five years.

Maps have been published recently at Tacoma, Wash., which shows that surveys for three railroads, starting at Grays Harbor and extending north into Olympic Peninsula, have been completed, the roads varying from about 110 to 125 miles in length. One survey was made for the Northern Pacific, one for the Union Pacific and one for the Chicago, Milwaukee and St. Paul Railway. The three surveys all parallel the coast and all touch the Quiniault Reservation.

PLANT, HIGHWAY AND LABORATORY INSPECTION OF BITUMINOUS MATERIALS.*

By Francis P. Smith, Ph.B.,
Consulting Paving Engineer, New York City.

BROADLY speaking, a comprehensive system of inspection of bituminous materials and pavements or roadways made from them may be subdivided as follows:—

1. Preliminary inspection of raw materials;
2. Inspection of materials and processes during construction work;
3. Inspection of finished work.

Preliminary Inspection of Raw Materials.—These are, or should be, assembled by the contractor sufficiently in advance of starting the work to permit of their being tested. They usually consist of refined asphalt or asphalt cement; residuum flux; crushed stone or gravel; sand; and filler. All of these materials should be sampled from deliveries actually on hand on the work. Except where the manufacture of the material is inspected at the refinery, this rule should never be departed from in the case of the bituminous materials themselves; i.e., the refined asphalt or asphalt cement and the residuum flux. In the case of the materials which constitute the mineral aggregate of the pavement or roadway, contractors are often unable to judge themselves whether or not a particular material passes the requirements of the specifications and before placing their order for them they frequently submit samples obtained from different dealers for approval. In the case of crushed stone or gravel, these samples usually fairly represent the kind of material which will be delivered. This is also true in the case of filler. With sands, however, samples submitted by the dealers frequently vary very greatly from actual deliveries. It often happens that the selection of sand has not been given sufficient attention or has been deferred until the last moment, with the result that no really suitable samples are submitted. In such cases it is frequently to the interest of all parties concerned, although perhaps not strictly the duty of the inspector, to personally visit and examine available sources of sand in the immediate neighborhood. In this way much better material may often be obtained than would otherwise be the case.

Sand and gravel banks are usually stratified and where the deposit has been made from comparatively still water the lower stratas will usually contain coarser material than the upper stratas. In every case the sand dealer should be impressed with the necessity of carefully stripping the top of the bank to remove deposits of clay, loam, etc., as this material is undesirable and will usually ball up in the heating drums. Where the stratas vary considerably and can not be dug separately, it will be necessary to take an average sample of the run of the face of the bank in order to determine what will be the composition and character of the average output of the deposit. In certain cases it is necessary to select definite stratas and have all the sand taken from them. In other cases the sand is dredged from river or creek beds and in order to obtain a satisfactory supply, it is sometimes necessary to go on board a dredge with a set of screens and a sand scale and sample the sand obtained from

*Public lecture delivered before the graduate students in Highway Engineering, at Columbia University on January 20th, 1914.

various portions of the river bed. When prospecting outlying country for available sand deposits, a small frying pan is a very convenient utensil to carry, together with the sand sieves and scales. By means of it, samples of sand taken from various pits can be dried over a small fire and sifted on the spot, which avoids the necessity of carefully marking them for identification and taking a lot of samples back to the laboratory or office. When securing samples of materials for examination, these should be carefully selected so that they really represent an average of the materials. The quantities necessary for examination are about as follows:

Refined asphalt or asphalt cement....	1 pound
Residuum flux	½ to 1 quart
Crushed stone or gravel	1 to 3 pounds
Sand	1 pound
Filler	½ pound

When these are sent to a central testing laboratory they should be plainly marked with the following information:

Kind of material,
Date material was received at paving yard,
Date when sample was sent,
Quantity of material represented by sample,
Name of manufacturer or from whom purchased,
Name of paving contractor who is to use the material represented by the samples,
Name of city or town in which work is being done.

Method of Obtaining Samples.

Refined Asphalt.—This is usually shipped in barrels containing from 300 to 500 pounds each. It will depend on circumstances and the quantity of material on hand how many barrels should be examined. Where the barrels are marked with the dates or batch numbers and different batches are represented, it will usually be sufficient to take a single sample from each batch. Certain specifications give a permissible limit of variation in the penetration or consistency of different shipments of asphalt. In such cases it will be necessary to test for penetration a sample from each batch number, in which case all of the samples taken must be kept separate. Where no such provision is included in the specifications and the inspector is assured from his past experience that the particular manufacturer from whom the material was purchased is careful in his output, a fewer number of samples will be necessary than under other circumstances. In some cases an average sample made up of different samples taken from the requisite number of barrels will be all that is required. The packages or barrels used by different manufacturers are very often characteristic of the product, and this is also true of the odor and general appearance of the material. A qualified inspector will often be able to determine from observation whether or not the contractor's statement as to the source of the material which he intends to use is correct. In taking the samples, material should be selected which is free from dirt, etc., and which has not been exposed to the air. In other words, a piece of refined asphalt should not be taken from the top or immediately adjacent to the outside of the barrel.

Asphalt Cement.—This is quite often shipped in tank cars and in such cases a single sample taken, preferably after the contents of the car have been melted, will be sufficient.

Crushed Stone or Gravel.—Various samples from different portions of the pile should be taken and mixed together, and from the mixed portion sufficient should be selected for test. It is always advisable to dig into the surface of the pile a little way in order to get material which has not been exposed to the atmosphere and which possibly has lost through the action of wind or rain, or both, a considerable portion of its fine material.

Sand.—It is almost impossible to secure a fairly representative sample of dry sand, as the coarser grains have a different angle of flow from the finer grains and are found in different portions of the pile. The pile should always therefore be dug into some distance below the surface until damp sand is reached. After sampling the pile in this way in a number of places, the samples so obtained should be mixed together and sufficient taken for test from the mixed lot.

Filler.—This is usually Portland cement or finely ground lime dust, and comes in bags. No particular difficulty attends the sampling of this material, but a sufficient number of bags should be opened and samples obtained from them and mixed together in order that the sample sent for test shall correctly represent the average quality of the material.

The examination of the samples so obtained is usually conducted in accordance with detailed specifications. As these vary somewhat in their requirements, it is impossible to lay down a general rule which will cover the examination of raw materials for paving work. After the materials have been examined in the laboratory and found to be suitable for the work and in accordance with the specifications, the inspector can frequently be of great service in suggesting to the contractor the best formula to use. All paving specifications allow considerable leeway as to the composition of the mineral aggregate and the percentage of bitumen required in the mixture. Sometimes the decision lies entirely with the engineer on the work and where he is fully competent to decide these questions it should, of course, be left to him. As the contractor usually has to assume a guarantee on the completed work, he naturally feels that he should be consulted as to the formula used. Sometimes his desire to reduce the cost of his work will lead him to employ a formula which, while complying with the minimum requirements of the specifications, is really not suited to the work in hand. Whenever possible, cooperation between the inspector and the contractor will always secure the best results and a little tact used in this connection will usually be all that is required. It frequently happens that two or more kinds of sand or stone have to be mixed together in order to secure a suitable mineral aggregate. Many contractors are exceedingly careless in keeping their different kinds of materials separated. Unless this is done it is impossible to make a uniform mixture of the various materials and provision for the piling in separate and convenient places of the different materials should always be made before they are delivered. This is a very important consideration and lack of attention to it will not only hamper the execution of the work but its quality as well. It is necessary and advisable to impress on all the dealers furnishing raw materials the necessity of a uniform supply. This is particularly the case with sand dealers, who are often small men who have been accustomed to supply sand to builders and parties requiring it in small amounts. Almost invariably, men of this type will not realize the great difference which a, to them, small variation in the mesh composition of the sand will make to the paving contractor.

Inspection of Materials and Processes During Construction Work.—These may be sub-divided into plant and street inspection.

Plant Inspection. During the progress of the work additional quantities of raw materials will from time to time be delivered to the contractor's plant. These should be sampled and examined in the manner previously described for the preliminary inspection of raw materials and no deliveries should be used in construction work until after they have been examined and tested and found to be in accordance with the requirements of the specifications. Owing to delays in the arrival of shipments this may at times be difficult, if not impossible, but in such cases, if it is inadvisable to shut down the work temporarily, the inspector should make all the tests possible at the plant in order to convince himself that the materials are suitable for the work. If he is able to determine definitely that they are unsuitable, they should, of course, be rejected and work shut down until other suitable material is available. At times it may be necessary for him to assume the responsibility of passing the materials and permitting their use pending an authoritative report from the central testing laboratory. Sometimes there will be but little risk in doing this; under other circumstances it may be advisable to permit the contractor to proceed with his work with the distinct understanding that if the materials are found not to comply with the requirements of the specifications he will take it up. Such an arrangement should only be made in writing and with the consent of the resident or supervising engineer. Where sand is delivered by wagonload, it will usually be sufficient to take an average sample of the day's deliveries and test it. Where the sand is delivered by rail or barge, the contents of each car or barge should be tested, if possible before unloading it. These instructions apply also to stone and gravel. It is so extremely important that deliveries of various grades of stone, sand and gravel should be kept separate that the speaker again wishes to emphasize this point.

Generally speaking, the processes involved in the manufacture at the plant of bituminous paving material are:—

Preliminary mixing and heating of the mineral aggregate.

Preparation and heating of the asphalt cement or bituminous binder.

Mixing of the heated mineral aggregate with the hot asphalt cement or bituminous binder.

Preliminary Mixing and Heating of the Mineral Aggregate.—The proportions in which the various constituents of the mineral aggregate are to be mixed will, of course, depend upon their character and the specifications under which the work is being carried on. The method of mixing the different ingredients depends somewhat upon the feeding arrangements at the plant and the disposition of the raw materials. In certain large plants the raw materials are stored in bins. In some instances these bins have automatic feeding devices which deliver the contents of the bins upon a conveyer belt. In such cases the automatic delivery devices should be set at the proper points and during their operation should be watched from time to time in order to see that they are delivering the desired quantity of material. With certain mixtures a mere inspection of the mixed aggregate as it is being fed to the heating drums will enable the inspector to roughly determine whether or not the proportions are being adhered to. With other types of mixtures this is very difficult to regulate by observation at this point. In the majority of instances, plants are not provided with storage bins of the type previously described and the materials are dumped in piles on the ground. These piles are usually arranged so that the material from them can be easily conveyed to the feeding device for the heating drums by means of wheelbarrows or horse slips. Where the mixture consists of sand and stone of various sizes, with a considerable proportion of stone, it is advisable to have the mixture made in a pile adjacent to the feeding device. This can frequently be done satisfactorily by having the requisite number of wheelbarrowfuls of the various ingredients dumped on a certain spot, this pile to be roughly mixed by shovels and then shovelled over into the feeding device. Where a simple mixing of two grades of sand is required, this can frequently be done satisfactorily by building a small box or boot around the bottom of the cold sand elevator and having the fine sand placed on one side and the coarse sand on the other side. One man on each of the two sand piles can then shovel the material into the box above mentioned in accordance with the mixing formula determined upon. Assuming that two parts of coarse sand were required to one part of fine sand, the man on the coarse sand pile would have to throw two shovelfuls of sand into the box to every one shovelful thrown by the man on the fine sand pile. The feeding of the sand thus thrown into the box would be attended to by a third man, who would feed it to the buckets of the elevator by means of a hoe or shovel. Usually the fireman who is in charge of the firing of the heating drums is able to supervise the operation of the feeding gang and see that they feed a properly proportioned mineral aggregate. In mixtures of sand and large sized stone there is liable to be a certain amount of segregation of the material in its passage through the heating drums. Certain plants are provided with an overheat screen to separate the heated material after is comes from the drums into the various sizes and distribute them into different bins. The material contained in these bins is then drawn out into the measuring box in definite proportions according to weight. This, of course, is the most accurate method of making mixtures involving the use of a large proportion of relatively coarse stone.

The function of the heating drums is to dry and heat the mineral aggregate. Unless ample air circulation is provided for to carry off the moisture in the shape of steam, the drying will not be effectively conducted. It is essential to regulate the rate of feed and the temperature of the heating drums so that the mineral aggregate delivered from them will be dry and at the proper temperature. This operation is usually in charge of the fireman for the heating drums. The most modern plants are provided with a pyrometer inserted in the delivery chute from the heating drums. This pyrometer has a plain or recording dial which is placed at the feeding end of the drums, where it is under the observation of the drum fireman. This makes it easy for him to regulate his fires and the rate of feeding necessary to secure the desired results. Where no pyrometer is inserted, it is necessary for him to test the temperature of the material issuing from the delivery end of the hot sand drums from time to time, as often as may be required in order to produce satisfactory results. It is a comparatively simple matter to take the temperature of heated sand, but where the mineral aggregate consists of large stone particles, it is a much more difficult and unsatisfactory operation. Certain types of mixing plants are so constructed that it is very difficult to obtain samples of the hot mineral aggregate before it is mixed with the asphalt cement or bituminous binder. Regardless of the difficulty involved, it is good practice to test the temperature of every batch of mineral aggregate in plants of this type before it is mixed with the asphalt cement; otherwise regular work cannot be expected. Even when the greatest care pos-

sible is exercised, there will be considerable variation in the mesh composition and temperature of the mineral aggregate as delivered to the mixer. The permissible variations are usually set forth in the specifications and should be closely observed. Mixtures which vary very greatly in mesh composition will require different amounts of bitumen in order to make the best possible type of mixture. Within ordinary limits, no correction will have to be made for this, but, generally speaking, a mixture containing a large proportion of fine particles will require more bitumen to cover these particles than a mixture containing a smaller proportion of them. This is due to the fact that the finer the mixture the greater the surface area to be covered with bitumen. This can, perhaps, be most clearly shown by taking the case of a 1-in. cube which it is proposed to coat with bitumen. In its original state there will be six sides having an area of one square inch each to cover. If this cube be cut into two cubes, there will be the original six sides plus two additional sides to be covered, and every time that the cube is cut there will be an increase in the surface area to be covered with bitumen. In order to secure a satisfactory output from the plant, it is absolutely essential that the greatest possible care should be taken in the mixing and heating of the mineral aggregate. In order to insure the proper mixing of the mineral aggregate, it will be necessary from time to time to take samples of the mixed aggregate and sift them for mesh composition. Owing to the extreme difficulty of securing an average sample of hot, dry mineral aggregate, great care must be exercised in selecting the samples. The arrangement of the plant and the kind of mineral aggregate used will determine where and how often these samples should be tested.

The speaker is inclined to advise the obtaining of samples for test from the overflow of the feeding device used in conveying the cold mineral aggregate to the heating drums. This is usually done by a chain and drum elevator. Where these buckets dump into the chute at the entrance of the drying drums, there is almost always a small overflow which gradually piles up underneath this chute. Assuming this to be the case, the pile can be cleaned off at a given time and the material which accumulates during, say, half an hour's run can then be sampled, dried and sifted. It is much easier to sample the damp material than it is the dry, and this not only obviates some of the difficulties attendant upon sampling dry material but gives the inspector an average of the material fed into the drums during the half hour while the pile was accumulating. In this way much better average results are obtained and the inspector is not liable to be misled by temporary and unimportant lapses in the feeding of the material. In other cases, samples of the hot material are obtained from the delivery end of the drying drums. In such cases a number of samples should be collected and mixed together and the resultant mixture sifted.

Preparation and Heating of the Asphalt Cement or Bituminous Binder.—For the preparation of the asphalt cement or bituminous binder, the contractor may purchase a hard bituminous material and add sufficient flux to it to bring it to the proper consistency, or he may purchase an asphalt cement of the proper consistency for use without the addition of any flux. In the first instance the melting kettles will have to be charged with the proper proportions of flux and hard asphalt to produce the desired asphalt cement. In large plants this is generally done at the close of the day's run. The materials are then kept under a gentle heat during the night and brought up to the desired temperature in the morning. The contents of the kettles are then thoroughly agitated in order to insure complete mixing of the different ingredients and a sample from them is taken and tested for penetration before the contents of this kettle are permitted to be used. If it is too hard, more flux will have to be added to it. If it is too soft, more hard asphalt will have to be added to it. After the additions are thoroughly melted, the contents of the kettle must be again agitated and tested before using. Certain asphalts are more difficult to flux than are others and require a longer period of heating. Overheating of the kettles will result in undue hardening of the asphalt cement. If the flux or hard asphalt contains any considerable proportion of water, this will foam very badly in the kettles and frequently cause them to run over. No asphalt cement or bituminous binder should be used until the water has been thoroughly removed from it. Where the asphalt cement or bituminous binder contains a considerable proportion of mineral matter or impurities, the contents of the melting kettles must be kept thoroughly agitated during the time that they are being drawn upon for use. Suitable mechanical agitation is, perhaps, the most advisable, as in this way the bituminous material is hardened less than if a steam or air blast is used.

Violent agitation with steam or air will very rapidly lower the penetration of the contents of the kettles. In the case of asphalt cements containing a considerable proportion of mineral matter, unless the contents of the kettles are thoroughly agitated, the material drawn from them will vary in purity or bitumen contents with the result that the portion first taken from the kettle will usually run much higher in bitumen than the portions last taken from it. Assuming that the proportions of the mixture have been set to give the desired quantity of bitumen, based on the average bitumen contents of a thoroughly mixed kettle, the mixture turned out with the asphalt cement first drawn from the melting kettle will be too rich in bitumen and that turned out with the asphalt cement last drawn from the kettle will be too low in bitumen. It is impossible to estimate by observation the changes in weights of asphalt cements necessary to overcome this and the only proper way, therefore, is to so agitate the contents of the melting kettles that the supply of the bituminous material drawn from them will be uniform in bitumen contents. If for any reason the asphalt cement for a certain day's run is not entirely used up, it should always be tested for penetration before permitting its use on a subsequent day's run. There is, of course, no objection to filling up the balance of the kettle with new material and mixing it thoroughly with the portion left from the previous day's run. It should then be considered as a new batch of asphalt cement and tested accordingly. Where hard asphalt and flux are to be melted together, the contractor should never be permitted to draw any material from the melting kettles until their contents have been completely melted and thoroughly mixed. Even where the asphalt cement is purchased ready for use, it is not good practice to draw from a kettle containing lumps of unmelted bituminous material. Sufficient melting kettle capacity should be insisted upon to avoid the necessity of doing this.

With the exception of the fluxing, the foregoing remarks apply equally to bituminous binders, purchased by the contractor, of the proper consistency for use.

Mixing of the Heated Mineral Aggregate With the Hot Asphalt Cement or Bituminous Binder.—It is unquestionably the best practice to weigh out the various ingredients entering into the composition of the finished mixture. Where the different ingredients are measured by volume, much greater variations will occur than when

they are measured by weight. If measured by volume, the contents of the various measuring devices must be carefully checked up before the commencement of the work and the gauges set at the proper point. It is advisable to check up the setting of these gauges from time to time to see that they have not been displaced, either intentionally or otherwise. In determining the volume occupied by the desired weights of the different ingredients, it is necessary to measure them at the temperatures and under the conditions used in actual work. In other words, heated dry sand or stone must be filled into the measuring box and the weight of the box when filled to the proper mark determined. This is also true of the bucket or measuring device used for asphalt cement or bituminous binder. If the asphalt cement should contain any water, this will produce foaming and it will be impossible to measure it accurately. If the foaming is at all excessive, it will be impossible to get the required amount of asphalt cement in the ordinary sized measuring bucket. This, by itself, constitutes a sufficient reason for not permitting the use of any asphalt cement which contains water. Where the materials are measured by weight, the tare of the empty measuring devices must be carefully obtained and this tare added to the weight of materials which it is desired to use. In determining the tare of the asphalt cement bucket, it must be borne in mind that after an hour's run there is a considerable accumulation, amounting to several pounds, of asphalt cement on this bucket which will increase its tare above that obtained by weighing the bucket in a perfectly clean state. After once determining the tares and setting the weights or gauges at the proper point, their position on the scale beams or elsewhere should be checked up from time to time to see that they have not been displaced. Occasionally the accumulation of surplus material on the scale platforms of the measuring device for the mineral aggregate will change the tare somewhat. Any such accumulation should be removed from time to time as often as necessary. Unforeseen happenings will occasionally influence the tare of the measuring devices. In the speaker's experience, he once found that the mixture being turned out was entirely too sloppy, although he had but a short time before carefully checked up the tare and gross weights of the various ingredients entering into it. Upon investigation, he found that the spout carrying the materials from the hot sand bin had been shifted by the vibration of the machinery so that it rested part of its weight upon the sand box, thus increasing its tare by approximately 200 pounds. Each batch of mixture turned out under these conditions, therefore, contained 200 pounds too little mineral aggregate, which, of course, accounted for its sloppiness.

The method of mixing varies in different plants. In the larger sized paving plants almost invariably the pug mill type of mixer is used, and this the speaker considers much the best type. The blades in this type of mixer should be examined to see that they are properly set and not unduly worn, thus producing an imperfect mixture at the bottom and sides of the mixer. Ordinarily they should revolve at a speed of from 60 to 80 revolutions per minute. In mixtures of the sheet asphalt type, one full minute should be allowed for mixing each batch of material. Where the mixture is a comparatively open one consisting largely or entirely of stone, this mixing time may be reduced somewhat. Whatever the type of mixer employed, the proper time for obtaining a thorough mixture should be determined and rigidly adhered to. The temperature of the mineral aggregate delivered to the mixer should be tested occasionally, as often as may be necessary. This, of course, will depend upon the type of plant used and is a check upon the drum fireman and the feeding operations of the mineral aggregate. The temperature of the asphalt cement in the melting kettles should also be tested as often as may be necessary in order to be certain that it is uniformly maintained at the proper point. Where the type of mixture permits it, frequent pat tests should be taken of the material delivered to the wagons. This test is made by placing a small quantity of the hot mixture upon a sheet of unglazed manila paper, folding over the paper and pressing down upon it with a wooden paddle. After it is thoroughly compressed, the paper should be struck a sharp blow with the wooden paddle and then opened for observation. An examination of the surface of the compressed mixture will clearly show to the trained inspector any marked variations in the mesh composition of the mineral aggregate. The depth of stain upon the paper will measure the amount of bitumen which it contains. The richer the mixture in the bitumen the heavier will be the stain. This stain is also influenced by the temperature of the mixture when the pat test is taken. For this reason it is necessary in comparing pats to know exactly the temperature. In obtaining the mixture for the pat test from the wagon, an ordinary mason's trowel will be found convenient. No time should be lost after obtaining the sample in putting it upon the manila paper and making the test; otherwise it will drop very considerably in temperature. The temperature of the material tested can be conveniently determined by inserting a thermometer at the place where the sample was taken from. Convenient and suitable arrangements for making this test should be insisted upon at the plant. This is a most important and valuable guide in the hands of a competent inspector and great attention should be paid to it. In the hands of a trained man, a variation of one-quarter of one per cent. of bitumen can be detected by means of the pat test. This pat test is, of course, not applicable to mixtures consisting chiefly of large particles of stone. The inspector should make careful notes of the various conditions surrounding the plant. He should take and record at least three times daily the temperatures of the asphalt cement and the mineral aggregate as delivered to the mixer. He should also record his siftings of the mineral aggregate together with the proportions used in making the mixture and of the asphalt cement.

All deliveries of material at the plant should also be noted and a record kept of any tests made on them. These records should be kept on properly designed forms and should state the name of the street on which the mixture is being laid, the kind of mixture and the kind and proportion of the various ingredients entering into it. He should also keep a record of the number of batches turned out from the plant, as this is a valuable aid in checking up the thickness of the pavement laid on the street. At the commencement of the day's run it is customary to send out mixture which is a little hotter than that sent out during the average operations of the plant. This is done in order to enable the workmen on the street to make a close and intimate joint with the pavement laid during the previous day's run. While safe temperature limits should not be exceeded at any time, the maximum limits should be approached in sending out the first few loads in the morning.

Street Inspection.—Prior to the delivery of any bituminous materials upon the street, the foundation must be completed in accordance with the requirements of the specifications. The finished foundation must then be

swept clean of all dirt, etc. Knowing the type of mixture to be laid and the number of pounds used in each batch and the number of batches per wagonload, it is usually possible to determine in advance how many square yards should be covered by each wagonload. The best street foremen, before laying any bituminous material, measure the width of the street and calculate the number of lineal feet which should be covered or "pulled" by each load. A tape is then laid along the curb and a chalk mark made at the point where the raked material from each load should end. Where the foundation is reasonably smooth and in accordance with the contour of the finished pavement, this method is one of the best checks for determining the thickness of pavement laid. Ordinary sheet asphalt pavement 2 ins. thick will weigh 200 pounds to the square yard. Pavements containing a large proportion of good sized stone will vary somewhat from this weight, but the exact weight per square yard can easily be determined during the first day's run.

As soon as the material reaches the street, its temperature should be noted. The hot material should be dumped outside of the spot where it is to be laid in order that all of it will have to be conveyed to its final resting place by means of shovels. This results in a preliminary spreading of material of approximately the same density. Where the load is dumped on the spot on which it is to be spread it will inevitably be tramped upon and certain portions of the heated mixture will receive more compression than others, which will eventually result in an uneven surface to the finished pavement. In certain classes of bituminous mixtures, notably those containing large particles of stone, where the haul is long, the coarser particles may settle to the bottom of the load. If this takes place to any great extent, the load when dumped should be re-mixed by turning over with hot shovels. In shovelling the hot mixtures into place the shovellers should not dig into the top of the pile but should shovel from the bottom of it, cleaning up the loose material as they go. If this is not done, the lower layer of the pile, in cold weather, will have become chilled by its contact with the cold foundation and it will be difficult to remove it completely and uneven distribution and compression will result. The mixture, after having been deposited roughly in place by means of shovels, is spread by means of hot rakes. During this operation the rakers should not stand in the hot mixture any more than is necessary. Care should be taken to maintain a uniform and even grade so that there will be no depressions in the finished pavement which will hold water. Some mixtures compress very much more than others, so that it is impossible to establish any definite rule for the depth to which the hot mixture shall be raked.

As soon as possible after raking, the mixture should be rolled. Some mixtures are more tender than others and must be allowed to cool off somewhat before putting the hot roller on them. The hotter the mixture, the greater will be the compression and it is, therefore, desirable to roll it as soon as possible. In very cold weather, especially when a strong wind is blowing, the surface of the mixture will chill quite rapidly. With a tender mixture it is often advisable to use a light hand roller over it as soon as it is raked in order to close up the surface and then follow this with a heavy steam roller as soon as the mixture will bear it. Undue delay in rolling the mixture will result in a more or less honeycombed surface. Depending upon the contour of the street and its width, the rolling should be first done parallel with the curb. This should be followed by diagonal or cross rolling and the final finish of the work by rolling parallel to the curb again. The exact method of handling the roller can usually be left in the hands of the roller engineer if he is an experienced man, as he should know how to smooth up the finish of the pavement better than will the average inspector. At the finish of the day's work it is necessary to leave the pavement in such condition that a proper joint may be made with it when the next day's operations are commenced. There are a number of methods of doing this. Perhaps the best is the rope joint in which a length of rope is laid across the extreme edge of the pavement and rolled into it while hot. When this is taken up very little cutting back will have to be done and the edge will be left in such shape that a satisfactory joint can be made. The practice of painting these joints with hot asphalt cement before laying fresh pavement adjacent to them is to be avoided whenever possible, as the tendency is to put too much asphalt cement on the joint. This asphalt cement is absorbed by the hot mixture and softens it at that point and traffic is liable to displace it. For the same reason the painting of edges of curbs, manholes, etc., should be done with extreme care. A very convenient instrument for determining the depth of the finished pavement is a putty knife with a blade 2 in. wide which has been marked across the face of the blade at a point corresponding to the required depth of the pavement. This can easily be inserted in the warm mixture after it has been rolled and the broad point will bridge over any small depressions in the foundation and avoid the recording of a greater depth to the pavement than really exists.

The use of hot smoothers should be avoided whenever possible. With the proper mixture and one which has been rolled while hot, the surface should be entirely closed up. Under unfavorable weather conditions, in order to close up the surface, it may be necessary in certain places to use hot smoothers. Care should be taken to see that these are not too hot; otherwise they will burn the pavement and scaling will eventually result. The inspector on the street should, whenever possible, keep an accurate account of the number of loads delivered. Knowing the number of pounds of mixture per load and the weight per square yard, he can then check up the yardage which should have been laid with the material delivered on the street if it were raked to the proper thickness.

Inspection of Finished Work.—If the inspection at the plant and street during the construction of the pavement has been adequate, the final inspection of the work will be chiefly confined to an examination of the contour and surface of the street. During this examination careful note should be made of whether or not the mixture has been thoroughly compressed and is closed up on the surface. Where there has been no inspection during the manufacture and laying of the pavement, or where this inspection has been inadequate, defects will frequently develop in the pavement. Under these circumstances, it becomes necessary to examine the finished work in order to determine the reason for the defects or failures. In an inspection of this sort, careful note should be made of the condition of the surface and its contour. Frequently marked depressions occur where the pavement has been laid over a trench dug just prior to its construction, and in which the back-filling was not properly done. A thorough examination of the street will usually involve the cutting out of numbers of samples of the bituminous surface. These should be carefully marked as to location and a sufficient number of them taken to fairly represent the surface examined. They should be sent to a central

laboratory for examination as to the per cent. of bitumen contained in them, the mesh composition and character of the mineral aggregate and the physical and chemical characteristics of the asphaltic cement or bituminous binder used in the pavement. Wherever these samples are cut out, careful note should be made of the depth of the pavement at this point. In many instances it will also be necessary to cut through the foundation to determine its character and thickness. Laboratory examinations of concrete foundations are usually not very valuable in determining the amount of cement which has been used in them, but a combination of physical and chemical tests of the foundation will often establish satisfactorily whether or not they have been defective. The method of examination used will, of course, have to be varied depending upon circumstances and the character of the defects which have been developed. The reasons for these defects have been fully covered by a previous lecture delivered by the speaker to which he would refer you for more detailed information on this point.

PANAMA-PACIFIC EXPOSITION CONSTRUCTION.

Rapid progress is being made on the construction work in connection with the numerous large wooden buildings for the Panama-Pacific International Exposition at San Francisco. Among the principal buildings already erected are the Palace of Machinery, covering three acres, the Fire House, the Education Building, the passenger station, and warehouses, ferry slips and oil houses. The framework has been started for the buildings for Mines and Metallurgy, Various Industries, Manufactures, Liberal Arts, Food Products and Agriculture.

Thirty-five states and territories and certain of the foreign governments have announced their intentions to secure space; 177 congresses and conventions have been arranged to meet in San Francisco during the fair, and an attendance of from 10,000,000 to 18,000,000 is anticipated for the exposition. It is said that neither Germany nor England will take exhibit space.

The cost of the exposition is estimated at $80,000,000, of which the state of California and the city of San Francisco will each pay $5,000,000, San Francisco subscribes $7,500,000 and individual exhibitors $25,000,000.

The Toronto Suburban Railway Company has just closed a contract with the Canadian General Electric Company, Limited, for substation apparatus and car equipments, for the new line which will run west from Toronto through Georgetown, Guelph and Berlin. A very interesting feature is that this will be the first interurban line in Canada to operate at 1,500-volts D.C. The catenary type of overhead construction will be used, and there will be three substations, viz., at Islington, Georgetown, and Guelph. 1,500-volt rotary converters, each of 500-k.w. capacity, will be used, power being transmitted to the substations at 25,000 volts. Provision will be made for the supply of power from a separate bank of transformers in each substation for distribution along the line for miscellaneous power and lighting purposes. The cars will be equipped with four 85-h.p. motors of the latest type, and fully ventilated. The control will be of the multiple-unit type. The cars will operate on 600-volt line at approximately half normal speed; and changing from 1,500-volt to 600-volt trolley, or vice-versa, will involve no loss of time in adjustment of control apparatus. The line with 1,500 volt operation will be about 61 miles long.

EFFICIENT WATER PURIFICATION IN SMALL PLANTS.

SEVERAL interesting papers and reports have recently appeared dealing with the operation of sewage disposal plants and emphasizing the necessity for more careful supervision of this kind of municipal work. It is well known to all who have investigated the matter that small sewage disposal plants receive as a rule little or no attention, and that their effluents could be greatly improved under proper operation.

As an instance of the application of this reasoning to water purification plants, one of our smaller cities operates a filter plant at an average efficiency of 79 per cent., and which was at one period as low as 50 per cent., whereas, according to a report just received from a consulting engineer, who has made a thorough examination of the system, an efficiency of 95 per cent. could be maintained if the plant was placed under proper scientific supervision.

Mr. H. P. Letton read a valuable paper on the subject, at a meeting of the New England Water Works Association recently. Mr. Letton was for some years in the employ of the New Jersey State Board of Health, engaged mainly in the supervision of the public water supplies of the state. He is now sanitary engineer to the United States Public Health Service. In his former position about 30 water purification plants were under constant inspection.

According to his paper, the main difference between the operation of sewage disposal plants and small water purification plants is that the former are usually built, not because there is a concerted demand for them, but for the eradication of a local nuisance, or by order of some higher authority. Because of this fact, and because the terms "sewage" and "sewage disposal" are distasteful to the average layman, the plant is generally put in an out-of-the-way place, and either forgotten entirely or placed in the charge of an underpaid, superannuated caretaker, who knows nothing of the principles upon which the design of the plant is based; while a water purification plant is generally installed as a result of a popular demand, and the consumer is directly interested in its operation in so far as furnishing a clear, colorless, and palatable water is concerned. These are the qualities that to the majority of people determine the purity of the water, and as long as they are maintained there is little or no question as to the efficiency of the plant in other ways. As a matter of fact, however, there are many plants which will usually meet the above conditions, but which are inefficient, both from an economic and a sanitary standpoint.

It is only on rare occasions that a filtration plant has been constructed at the time of the installation of the water works system. In most cases, when the purification plant is added to an existing system, the operation of it is intrusted to the engineer of the old plant. This man may be, and in many cases is, a stationary engineer who thoroughly understands the operation of boilers, engines, and pumps, but who has absolutely no idea of the principles which underlie the process of water purification.

There is also another point which in many cases affects the results obtained. When it is decided that some form of purification is advisable in connection with a small water plant, it is very rare, indeed, that a consulting engineer is called in for advice. Instead, the matter is taken up with one or more companies engaged in the business of installing purification apparatus. While

these companies are usually competent to give reliable advice, their main business is the selling of equipment. Because of this fact and because the usual small water company or municipality is weak financially, the filter plant is designed to fit the available money, and the company offering the equipment for the least sum is generally given the contract, regardless of the quality of the material to be furnished. As a result of this practice, plants that are poorly designed, lacking in the necessary equipment for efficiency, or even wholly ill-adapted to the situation, are commonly met with. A few cases of this kind which have come under the observation of the writer will be noted. Probably the worst example was at a plant supplying about a million gallons per day. The supply was originally obtained from artesian wells, but on account of the high iron content of the water, a new supply was obtained from an artificial lake. This water was highly colored by its passage through cedar swamps. From the lake the water flowed by gravity to the coagulation basin. This was a rectangular wooden tank of such size that normally less than twenty minutes were allowed for coagulation and sedimentation. During periods of high consumption the time was considerably decreased. The basin was set at such an elevation that at times of low water in the lake it was impossible to obtain the normal supply except by by-passing some raw water. From the coagulation basin the water flowed by gravity to 4 rapid sand filters of the gravity, circular wooden tank type, without loss of head-gauges or rate-controllers. The agitating rakes were intended to be driven by a water motor, but the necessary power was lacking. The beds were, therefore, not agitated during washing. From the filters the water passed to a suction well which had been used in connection with the former well supply, and which provided less than 30 minutes' storage. Two solution tanks had been provided and connected with a small displacement pump driven from the line shaft to which the main water pumps were attached. The small solution pump was intended to force a solution of sulphate of alumina into the raw water just before it entered the coagulation basin. At the time of the writer's first visit to this plant the chemical pump was out of order and no chemical was being added. It was afterward learned that this was its chronic condition. Tests of the raw water showed it to be slightly acid owing probably to humic acid from the cedar swamps. Consequently the addition of sulphate of alumina would be an absolute loss as far as results are concerned. Analyses of the raw and filtered water showed no material difference, and the filtered water had at times a color as high as two hundred.

While the foregoing may seem to be an extreme case, conditions almost as bad were found in several instances. Two other plants were discovered treating acid water with sulphate of alumina only, rate-controllers and loss of head-gauges were almost unknown, and the methods of regulating the amount of chemical applied were very crude. Few calibrated orifice boxes were found in use. Two gravity, rapid sand plants, treating waters high in organic matter and often turbid, had no coagulation basins, so that they required too frequent washing with corresponding reductions in bacterial efficiency as well as increased costs of operation. Another large plant, using the pressure type of filter, was treating a turbid water with very little time for coagulation. The effluent was frequently turbid, and at times contained aluminum hydrate.

One plant of the slow sand type had less than a foot of filtering sand, and had a clear-water well holding about a half hour's supply. As a result of this combination, the rate of filtration fluctuated exactly as the demand, and purification was practically nil.

At one rapid sand plant the clear-water basin was so small that it was necessary to wash with raw water. Another plant had no arrangement for filtering to waste, so that whenever it was necessary to get at the strainer system the dirty water in the bed was drained into the clear-water well.

On the matter of operation, conditions were found to be as bad, if not worse. As has been said, the man in charge of a small water purification plant has usually little or no idea of the nature of the process. He operates the plant by "rule of thumb" methods in an endeavor to produce a good-looking water. Although efficient results depend so largely upon the use of the correct quantity of coagulant, the greatest ignorance was shown of this matter. At several plants the engineer stated that he put in a certain number of buckets of alum per day. He did not know how many pounds were used, and made no attempt to add it in the same proportion at all times. A few engineers said that they increased the dose "some" when the water was turbid, but did not know how much. In only a few plants was any attempt made to regulate the dosage by the aid of alkalinity and turbidity tests. As a matter of fact, few of the men in charge could be depended upon to make the necessary alkalinity tests. At only two plants, treating less than twenty million gallons per day, were laboratories maintained, and at these plants the tests, both chemical and bacteriological, were made under the direction of non-resident chemists. The engineers who made the tests were unable to interpret them or apply them in the operation of the plants. At one modern municipal plant, absolutely no records were kept. The chief engineer could neither read nor write, and could see no use in records of any kind, not excepting pumpage records. The president of the board of water commissioners in charge of the plant stated that the only reason he could see for filtering water was to remove turbidity, notwithstanding the fact that the sewage of over a hundred thousand people was discharged in the river, from which the supply was taken, about seventeen miles above the intake.

At one plant visited, it was found that through the laziness of the engineer the filters were not being washed enough, the deficiency of water due to clogging being made up by by-passing raw water. At another plant, the beds were washed too often, resulting in a low bacterial efficiency and a high cost of operation. Oven ten per cent. of all water filtered was being used for wash water.

It is not believed that such cases are confined to New Jersey. Reports of investigations in Ohio, Pennsylvania, New York, and Illinois show very similar conditions. Much as they are to be deplored, the fact remains that they do exist, and that a discussion of possible remedies is in order.

The most feasible remedy for poor design is a statute requiring the submission of plans for proposed plants or changes in existing plants to the state board of health, or some other state authority, for approval before construction can legally be carried out. Such a regulation is in effect in a number of states at the present time. Coupled with the appointment of a properly qualified engineer to pass upon all plans, it will satisfactorily care for new works. State supervision for existing plants will, if carried out, do much to remedy the more serious imperfections of construction and operation. This supervision cannot, however, be thorough enough to furnish definite information for the efficient operation of the

plant, both from an economic and a sanitary standpoint. At best, the plant can be visited only about once a month, and this visit is merely to see that a safe and potable water is being produced. From the viewpoint of the state this result is sufficient, but from that of the consumer and taxpayer there are other matters of great importance. He wishes to know, first, that the water is healthful, and then, that it is not possible to obtain the same or better results at a less cost by some change in the method of construction or operation of the plant. This latter is out of the field of the state inspector, for it generally requires much experimenting and testing to obtain the point of maximum efficiency.

The plan of having the engineer at the plant make daily tests under the general direction of a consultant at a distance is a step in advance, but it is far from perfect. The engineer's results are open to question, since he is often hurried and makes the tests without knowing the reason for the various steps. Also, since he has but infrequent consultations with the consulting engineer or chemist and is unable in most cases to explain any seeming discrepancy in his results, they do not prove to be of as much value as might be expected.

The writer has had in mind for some time a plan for remedying this situation, and it has recently again been brought to his attention by a similar plan which Prof. Earle B. Phelps has put into operation in connection with local health administration in several small Massachusetts towns. The plan is this: For several water companies or municipalities located not too far apart to combine forces, fit up a laboratory at some central point, and employ a competent bacteriologist and chemist to give his entire time to the scientific supervision of their water plants. By so doing, each plant would have the benefit of expert advice at a small cost. It would be possible for the chemist to visit each plant one or more days each week, and by so doing to become familiar with its operation. He could instruct the engineer in charge of the plant how to make the necessary daily chemical tests, such as alkalinity, turbidity, etc., and since he visited the plant so often, these results could be checked up and would be reliable. In case of emergency he would be able to look after the sanitary quality of the water and thus protect the consumer. He would be able to carry on experiments upon the proper amount of coagulants to be used, and time of coagulation. There is a chance for much study in the manner of washing the filters to bring about efficiency and economy. This is a point not considered much in small plants, but which has a considerable bearing on the cost of operation. It requires many visits to a plant to become familiar with its operation and to suggest changes which will increase its bacterial efficiency without increasing the cost. It is believed that the scheme outlined would in many cases save money for the water company or municipality, besides giving them and their consumers confidence that the quality of the water was being safeguarded.

A group of English engineers were recently accorded the contract for bridging the Ganges of northern India, which issues from an ice cave at the foot of the Himalayan range of mountains. This bridge, which is over a mile in length, is to carry the Eastern Bengal State railway over the Ganges from Damukelia to Sara Ghat. Spanning the river, the bridge will be crried on steel trestles, which in turn will be supported on massive steel grilles in granite piers. The contract consists of fifteen main spans, each 359 feet long and 52 feet high, and weighing 1,300 tons, and will require an expenditure of about $1,250,000.

ESTABLISHING A RAILWAY ROUTE

By J. A. Macdonald, Ottawa, Ont.

RUNNING **the Preliminary Line.**—Having, by reconnaissance, found approximately the location for the proposed road, the next procedure is to run a trial line with the transit, selecting what appears to be the best on the ground, staking out the centre line, and sketching in the topography on both sides.

In following the bed of a stream, we obtain, generally, a line similar to *A N C* upon the section (Fig. 1). The lowest line of the valley, though quite moderately inclined at first, may rise more and more rapidly towards the source of the stream, as shown by the closer approach of the contour lines on the plan. That the line may ascend at a uniform rate from *A* to the summit, the horizontal distance between the contour lines may be equal at all parts of the ascent. This condition is effected by causing the surveyed line to cut the contours at right angles during the first part of the ascent, and obliquely as the summit is approached, or as the contours become closer together. In this manner we obtain the profile *A M*, *M A*. The contour line is level; the line cutting the contour at right angles is the steepest line that the ground admits of; and as we vary between these limits, we vary the inclination.

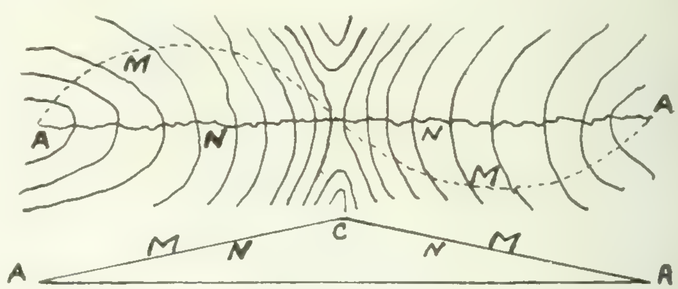

Fig. 1.

The effect upon the profile of cutting the contour lines in different directions is shown by Figs. 2 and 3. If we connect the points *A* and *B* upon the plan (Fig. 2) by the straight line *A B* we obtain the profile shown in Fig. 3 by the line *A L N M B*. If we follow the contour line around from *A* to *B*, we should have the horizontal line *A B* on the profile, and if we select a route upon the plan midway between the straight line and the contour line, as *A E F H B*, we shall have, as the corresponding profile, *A E F H B*, (Fig. 3). In connecting the points *C* and *D*, which are at different elevations, by the straight line, *C D*, we get the profile *C I P K D*. If we wish to descend upon the natural surface at a uniform and given rate—from *C* to *D*, knowing the rate of incline and the vertical distance between the contour lines, we get at once the corresponding horizontal distance from one contour line to the next, which, applied to Fig. 2, would give the required descent, as shown on the profile by the straight line from *C* to *D*. The line *A E F H B*, on the plan, is, of course, longer than the straight line *A B*; and the contour line is longer still. Such increased length is not represented upon the profile, as the object has been simply to show the general relation between the plan and profile, and the use of correctly drawn contour lines in adjusting any route to the ground.

General Establishment of Grades.—In the application of grades or incline to the establishment of a rail-

way route, we should bear in mind that between two points, which are at the same absolute elevation, there should be as little rise and fall as possible, and that between points at different elevations we should endeavor to have no rise while descending, and consequently no fall upon the ascent. These conditions can seldom be exactly complied with in practice, but we may approach them closely. In many cases we have to choose between two systems of grades—the one involving a long but gradual and uniform rise, the other a short but steep ascent, with the remainder of the line level, or nearly so. The total resistance upon the two systems, involving the same amount of ascent, will be the same; but a great difference may be made in the method employed in overcoming that resistance. If we have a grade 10 miles long, rising at the rate of 20 ft. per mile, we adapt our

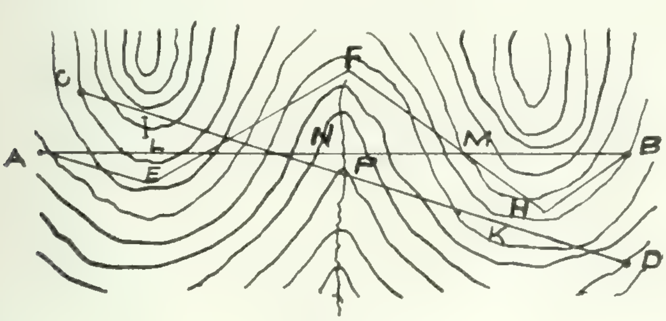

Fig. 2.

machinery to hauling its ordinary load up that incline, and we require from it a constant expenditure of power while ascending, and on the descent it is profitably aided all the way by gravity. If, however, the first 8 miles are level, and the remaining 2 miles ascend at the rate of 100 ft. per mile, an engine to work the incline would be too heavy for the level portion, and in the descent we should have more aid from gravity upon the incline than we required with none at all upon the level.

The effect of the arrangement in detail of the grades upon the amount of work to be done in reducing the natural surface of the ground to the finished roadbed, is shown in Fig. 4. The level grade from *A* to *B* involves a large amount of earth cutting at *D* and *E*, and a large amount of embankment at *C*. By raising the grade lines *D′* and *E′*, in the cuttings, and depressing the level em-

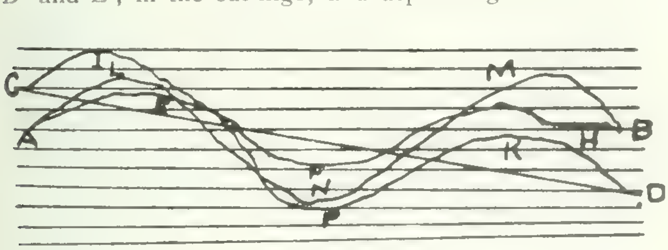

Fig. 3.

bankment from *C* to *C′*, we at once reduce both amounts of excavation and embankment, and by raising the roadbed more, to *D″* and *E″* in the cuttings, and depressing it to *C″* upon the embankment, we reduce still more the quantity of work to be done, but at the same time we render the road more difficult of operation.

There are many points that govern the rate of grade of a new railway. Probably first of all is the capital at disposal of the promoters of the road; for plenty of money will make possible an almost level line. But often the tremendous cost of such a level road would never pay dividends, notwithstanding this advantage. The country through which a road is to pass largely governs the most economical grade. If a comparatively level country, then there is no necessity at all for steep grades on the grounds of economy. If, on the other hand, the country is rough, the grade must be made to conform first with the amount of capital available, and, secondly with operating expenses.

The question of interest at which the money can be borrowed also enters very largely into that of grades.

It is doubtful if it were wise economy on the part of the C.P.R., when building its road across the continent, to make the grade limit so steep. Money was at a much lower rate at that time than now, and the vast sums of high-priced money that have been used in the past few years to ease the gradients might better have been used on the original work. This goes to show that faith in a railway enterprise also governs the gradient. When the C.P.R. line was being constructed a great many people had little faith in the successful outcome of the enterprise, while the problem of crossing the Rockies was

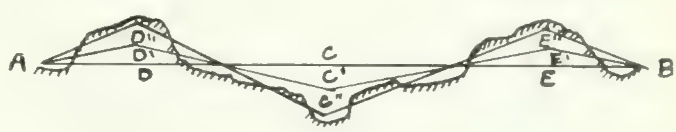

Fig. 4.

considered by many to be almost an impossibility. Money-lenders, not being greater endowed with prophetic powers than any other class of people, held the general view, and it was only with the greatest difficulty that the money could be found to construct the road on the original plan of steep grades. Faith in any enterprise is, therefore, of great importance, and particularly so in the building of a railway.

We think the reconnaissance line of a railway of considerable length is not generally given due importance in this country. Certainly, no decision as to suitable grades and curves should be arrived at before a full report of the exploration or reconnaissance survey has been received. We also think that these exploration surveys are not usually complete enough. Besides determining the most economical ruling grade, the possibilities of the country as to production, available freight and passenger service, contiguity to water transportation, are of almost equal importance with the gradient. These latter points, however, are usually neglected in the exploration line, the whole interest being centered in the grades.

A statistical report on the operation of electric railways throughout Canada in 1913 has recently been published at Ottawa. There are 56 electric railways in Canada, and during the year ending June 30th, they carried 598,662,801 passengers, exclusive of transfers, and 1,957,930 tons of freight. There was an increase in the number of passengers over 1912 of 108,998,119. The mileage of the railways increased during the year by 142 miles. The gross earnings of the electric roads in [illegible] was $25,216,111, an [illegible] over 1912 of $4,716,861. In five years the earnings of the electric railways have more than doubled. During 1913 the earnings from passengers was $19,794,400; from mail and express, $72,516 and from freight, $1,211,871. The operating expenses amounted to $17,765,372, leaving $10,450,738 as gross corporate income in addition to $1,318,909 of miscellaneous income, making a total income of $11,[illegible]. A surplus of $2,058,742 was carried after taxes, debt, interest and dividends were paid; and an addition of $55[illegible] was made to the reserve.

NELSON AND CHURCHILL RIVER BASINS.

A REPORT (Memoir No. 30) has recently been issued by the Geological Survey Branch, Department of the Interior, on the basins of the Nelson and Churchill Rivers. The information was compiled by Mr. Wm. McInnis and is largely the result of his own personal investigations. References are made also to the geological work of Bell, Tyrrell, Low, Cochrane, McConnell and Dowling, all of the Geological Survey.

Topography.—The region, broadly considered, forms part of the extensive Pre-Cambrian peneplain of northern Canada, encroached upon, to the northeast, south, and west, by more recent, flat lying, sedimentary rocks. The peneplain surface has an elevation, in the northwestern part of the area, of from 1,300 to 1,500 feet above the sea, but gradually diminishes in height eastward to the broad declivity through which Nelson and Hayes rivers,

Fall on the Rapid River, Near the Churchill.

and, in part, Churchill River, flow to the sea. In the neighborhood of Sipiwesk Lake, which lies about in the middle of the depressed area, the elevation of the surface above sea-level is about 600 feet. There are no high elevations, and the general level of the interstream areas is not more than 100 to 200 feet above the level of the streams.

The plateau has a gently rolling surface characterized by rounded outlines which have resulted from long continued and profound erosion. It is intersected by rivers and streams innumerable and is dotted with lakes of all sizes. The river valleys are moderately depressed, and are made up generally of chains of rock-bound basins which form series of lake-like expansions along the rivers, the water spilling over the lowest part of the rims and flowing from basin to basin with swift current or over a succession of rapids and falls.

The surface is wooded throughout, though, except in the valleys of the larger streams, the forest growth is of small size. North of latitude 59° or thereabouts, the forest is mainly black spruce and tamarack of stunted growth, a growth which characterizes also the muskeg portions of the southern area.

To the northeast, where the horizontal limestones of the Hudson Bay basin overlie the older rocks, the surface is of the nature of a gently sloping, flat plain. The level character is due, in part, to the horizontal attitude of the rocks and, in part, to a covering mantle of boulder clay

Sea-river Fall, Nelson River.

of somewhat uniform thickness. In this, and to some extent in the underlying, solid rock, the rivers have trenched narrow channels, which constitute the only breaks in the surface.

The overlap of the Cretaceous sediments to the south is marked for a hundred miles west of Lake Winnipegosis by the bold escarpments of the Porcupine and Paskwia hills, and farther west by the equally high but gently sloping outlines of the Wapawekka hills.

The country about Montreal Lake and east of it is characterized by heavy accumulations of drift. which form somewhat prominent hills that reach heights of over 2,000 feet above the sea.

Drainage.—The whole of the area under consideration, except a small tract in the northwest corner, is drained by rivers flowing to Hudson Bay; of these, the Nelson and Churchill are the largest, the first named taking rank among the half-dozen largest rivers of the continent.

Sturgeon-wier River, Saskatchewan.

The Nelson, which empties from Lake Winnipeg into Hudson Bay, is 1,660 mi. in length, measured to the head of its longest tributary, the Bow, and drains an area of 370,800 sq. mi., of which about 313,000 sq. mi. are in Canada. Its drainage basin embraces all the country, westward to the mountains, lying between the watersheds of Churchill and Athabaska rivers to the north and the Missouri to the south, and eastward to the

head-waters of Albany River and to within 50 mi. of the head of Lake Superior.

Its volume is computed to be 118,400 cu. ft. per sec. at extreme low water, measured just below Sipiwesk Lake and above the inflow of the large tributaries, Clearwater, Grass, and Burntwood rivers. The river is made up, by the union in Lake Winnipeg, of the Saskatchewan, Red, Assiniboine, Winnipeg, Berens, and many smaller rivers, and is augmented in volume after leaving the lake by receiving several large tributaries.

The water of the river is somewhat murky from suspended sediment, but gradually clears as it passes through the numerous lake expansions along its course, thus the amount of matter in suspension is 2.565 gr. per Imp. gal. below Lake Winnipeg and only 0.552 gr. near the mouth. The water of the Saskatchewan, near Cumberland, was found to contain 16.60 gr. of solid matter to the Imp. gal., while that of the Nelson, below Sea-river falls, contained 17.1 gr., and at its mouth, 12.528 gr.

The Churchill is 1,000 miles in length and has a drainage basin 115,500 sq. mi. in area. The water along part of the river's course is slightly murky. It contains above the mouth of Reindeer River, 7.96 gr. of dissolved solid matter to the Imp. gal. As is the case with the Nelson, the many lake expansions serve as settling basins, and the water, before reaching Hudson Bay, becomes quite clear. Its largest tributary, Reindeer River, flowing from Reindeer Lake and draining, as it does, part of the Pre-Cambrian peneplain, has very clear water, containing 2.02 gr. of dissolved solid matter to the Imp. gal.

Hayes River, with a length of 180 mi. and a drainage basin about 28,000 sq. mi. in area, drains a belt along the eastern edge of the area mapped; its water is remarkably free from suspended sediment, and carries only 0.878 gr. of solid matter to the Imp. gal.

The tract to the northwest, above referred to, sheds its water westerly into Athabaska Lake, to finally reach the Arctic Ocean by Slave and Mackenzie rivers.

Water-powers.—The total amount of power capable of being developed from the many falls and rapids which occur on the rivers within the area, is almost incalculable. Some of the rivers are of great volume and all, along parts of their courses, have rapid descents.

Of the rivers, the Nelson, by reason of its great volume and numerous falls, is the most important from the point of view of power development. Between Lake Winnipeg and Split Lake, a distance of about 230 mi., the river has a descent of 240 ft., and between Split Lake and the sea, 200 mi., a descent of 470 ft. The greatest fall occurs in the portions of the river between Cross and Sipiwesk Lakes, where there is a total descent of over 90 ft. in 28 mi., and between Gull Lake and the foot of Limestone Rapid, where the descent is 396 ft. in about 67 mi. There are a great many lake expansions along the course of the river, and between them, rapids and falls, to the number of fifteen or more, occur. Some of the falls offer excellent sites for water-power plants, and at several the vertical drop is considerable: at Ebb-and-Flow Rapid there is a fall of 11 ft.; at Whitemud Fall, 30 ft.; at Bladder Rapid, where the whole river flows in one channel for the first time after leaving Playgreen Lake, 11 ft.; at Over the Hill Rapid, 10 ft.; at Redrock, 10 ft.; at Grand Rapid, 20 ft.; at lower Gull Rapid, 50 ft.; and at Kettle, Long Spruce, and Limestone Rapids, drops of 50 ft. within a mile or so of distance.

When the great volume of the river is taken into consideration, amounting to 118,400 cu. ft. per sec. at low water, or about four times the volume flowing over the Chaudière Falls at Ottawa and one and a half times that at Sault Ste. Marie, it will be seen that the total amount of available power is very great.

Other high falls are Missi Fall on Churchill River, just below Southern Indian Lake, where the vertical descent is in the neighborhood of 20 ft.; Grand Rapids, at the mouth of the Saskatchewan, with a descent of nearly 100 ft.; a fall 30 ft. in height on Rapid River near the Churchill, and Manazo Fall on Burntwood River where the vertical drop is about 30 feet. In addition to these, falls and rapids almost innumerable occur along the courses of all the rivers and streams of the region.

In a report on the water-powers of Canada, published by the Commission of Conservation in 1911, an estimate is made of the horse-power available at a few of the falls and rapids within the district. On the Saskatchewan the estimate is made for only two of the rapids, namely:—

Cole Rapid, minimum h.p.	14,700
Grand Rapid, minimum h.p.	80,000

Trout Fall, Above Knee Lake, Hayes River.

On the Nelson River the horse-power is calculated for eleven rapids, and aggregates 6,859,000, divided as follows:—

	Approximate head, in feet.	Estimated horse-power.
Limestone Rapid	85	1,140,000
Long Spruce Rapid	85	1,140,000
Kettle Rapid	96	1,290,000
Gull Rapid	67	900,000
Birthday Rapid	24	320,000
Grand Rapid	20	270,000
Rapids above Sipiwesk Lake	31	416,000
Whitemud Fall	30	403,000
Whitemud Rapid	30	403,000
Ebb-and-Flow Rapid	11	148,000
Rapids above Cross Lake	45	605,000

The report for 1913 of the B.C.E.R. Company of Vancouver, B.C., shows a construction of 36.07 miles of new line, as follows:—Vancouver and suburban system, 9.66 miles; and Victoria city system and Saanich interurban line, 26.41. The total single track mileage of the system, December 31, 1913, was 370.09. During the last year the company has made the following additions to its rolling stock:—Three closed passenger motor cars, 43 feet 4 inches long; two combination passenger and mail motor cars, 38 feet; 30 freight box cars, 60,000 tons capacity, 40 feet; 30 freight flat cars, 60,000 tons capacity, 41 feet; three sweepers for city service, 28 feet 3 inches; 15 logging cars, 80,000 tons capacity, 42 feet.

PURE vs. IMPURE DRINKING WATER

The bearing which the impurity of water supply has upon the typhoid death-rate was indicated fairly well in an article by Mr. J. W. Ellms, filtration superintendent, Cincinnati Waterworks, in the December, 1913, issue of the American Public Health Journal. The article referred to conditions in Cincinnati before and after a purified water supply had been established.

For the three years preceding the installation of a purification system the typhoid death-rate averaged 53 per 100,000 population. For the five years following the purification of the water supply the death rates per 100,000 were 19, 13, 5.7, 11.4, and 7.1, respectively This represents an average reduction in the number of deaths from this disease of nearly 80%. The reduction in the cases reported is very nearly 85%, when estimated for this same period. Whether other sanitary reforms approximately coincident with the purification of the water supply have not played some part in the diminution of cases from this disease, the writer is not prepared to say; but there is little doubt that the principal agency has been the substitution of a pure for an impure drinking water.

A study of the accompanying table with a view to establishing some relation between the fluctuations in the typhoid death-rate and the quality of the water does not lead to any very positive conclusions. It immediately raises a question as to whether we really obtain any direct measure of the purity of a water in the usual bacterial examinations which are made. So far as the total number of organisms removed is concerned these results indicate a water of high purity. On the other hand, the presence of fecal or gas-producing organisms likely to be associated with the typhoid bacillus, as shown by the presumptive positive B. coli figures, would lead one to believe that the entire absence of these organisms in a water is by no means absolutely necessary as an indication of what experience has shown to be a safe drinking water. The reduction in the number of B. coli effected by filtration alone is evidently in the same proportion as that obtained in the reduction of the total number of bacteria. No selective action takes place in filtration, although there appears to be some such action when the disinfecting agent, calcium hypochlorite, is used.

So long as bacteriology is unable to furnish reliable and rapid methods for the isolation of pathogenic organisms in water, it will be necessary to rely on circumstantial evidence, such as has been furnished by the remarkable reduction of typhoid fever in Cincinnati, following the introduction of a purified drinking water. Since all those cases, in which the source of the infection remains untraced, may have been infected through agencies such as flies, shell-fish, raw vegetables, fruits and bacillus carriers, it reduces the probability of our present purified drinking water being a source of infection to practically zero.

Comparison of the Typhoid Fever Death-Rate With the Hygienic Quality of the Water Supply of Cincinnati, 1909 to 1912.

	1909.	1910.	1911.	1912.
Typhoid-fever death-rate per 100,000 of population	13	5.7	11.4	7.1
Percentage reduction from average death-rate for three years preceding introduction of filtered water supply	75	90	79	89
Average number of bacteria per c.c.—				
In river water	9,300	8,900	13,790	11,130
In filtered water	75	75	39	26
Percentage reduction of bacteria by purification	99.2	99.2	99.7	99.8
Yearly percentages of presumptive positive B. Coli results obtained in various amounts of the river and filtered water—				
In river water in 1 c.c.	93.2	91.0	85.3	93.5
In filtered water in 1 c.c.	1.0*	7.9*	5.2†	3.0‡
In filtered water in 100 c.c.	66.0*	65.0*	84.3†	51.6‡
Percentages of presumptive positive B. coli results in 100 c.c. of filtered water for the period of disinfection—				
Before disinfecting filtered water	....	....	88.9	89.3
After disinfecting filtered water	....	....	12.8	27.7

*No sterilizing agent used. †Disinfection with calcium hypochlorite for first three months of 1911. ‡Disinfection with calcium hypochlorite for first six and one-half months of 1912.

The project is being advanced by the Conservation Commission of New York State, which is akin to that of the Hydro-Electric Commission of Ontario. It is proposed to conserve, own, and develop, all the water powers in New York, so that eventually every factory in the state will be operated by electric energy and every house illuminated. It involves the further use of the Niagara Falls on the American side, the use of the Long Sault Falls, on the St. Lawrence, the Genesee Falls and the surplus water of the barge canal between Troy and Schenectady. Power on every stream in the state, will be taken over, and connected with the general plant so that in time the state, for many purposes, if not for all, will be independent of the coal interests.

Some time ago the company which supplies Berlin, Germany, with electric current, acquired lands with extensive deposits of lignite or brown coal at Bitterfeld 83 miles south of Berlin, and decided to build a power plant there to generate electricity for Berlin. Upon further exploration, however, the deposit of lignite turned out to be so vast that the company determined to build a plant large enough to supply all the towns within a radius of about 100 miles. The company thinks that it has an ample supply of lignite for nearly a 100 years. It will turn the coal directly into electricity; and this it proposed to do so economically that electricity will be used even for cooking and heating, because no other kind of fuel will be able to compete with it in price.

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CONTENTS OF THIS ISSUE.

DEFECTS IN THE TORONTO BUILDING BY-LAW.

There is an annual waste of at least three-quarters of a million dollars in the construction of buildings in Toronto. This statement in Prof. Young's report to Judge Denton in connection with the investigation into the manner in which the work of the City Architect's Department is being conducted strongly substantiates the introductory reference to the structural features of the by-law being lacking in conformity with good engineering practice.

In May, 1911, a Citizens' Committee, composed of prominent representatives of Toronto's technical and business organizations undertook a careful study of the by-law which was then in force, and, after detailed comparisons with those of other cities, drafted a memorial to the City Council, urging a speedy revision, and outlining the important alterations, with proposals for their rectification. A year later the draft of a new by-law was completed by the city, in which a little of the undue severity of the old by-law towards reinforced concrete construction was removed. Much credit is due the Citizens' Committee for the modification of many of the restrictions. It is regrettable that the recommendations advanced in its memorial were not more extensively adopted.

During the past month the City Architect's Department has been under civic investigation, with a view to ascertain to what extent alleged inefficiency was founded upon fact. The investigation has included a consideration of the existing building by-law, and Prof. C. R. Young was retained as consulting engineer to interpret its chief unfavorable features. Some of the more important of them are enumerated in the article appearing on another page of this issue.

Striking among the defects of the present by-law is the discouragement which it presents to prospective industries. In addition to the remarkable lack of inducement held out to them to locate in Toronto, the high price of land and the unrelenting taxation are accompanied by another repelling force in this advanced cost of construction of buildings. Toronto, a most favorable location, geographically, barricades itself against desirable industries by measures that make conditions prohibitive to them.

PROMOTING EFFICIENCY IN SMALL WATER PURIFICATION PLANTS.

With our present development of the art of design and operation of water plants, and especially those plants which rely upon some form of chemical treatment, there exists an entirely inexcusable neglect of the equally important matter of daily operation. More particularly in the case of small plants do these discrepancies show themselves. In Mr. Letton's paper, appearing, in part, in this issue, some distinctive points are presented on the manner in which the typical small water purification system is inefficient, and some remedies worthy of note are suggested.

The operation of a small plant is undoubtedly a difficult problem. It requires the same class of skilled supervision that a large plant must have. Attention of this kind makes the cost of maintenance high, showing up very prominently when the operating costs of the plant are compared with those of another plant of 50 or 100 times the capacity. The appearance of excessive cost of supervision is prevented by employing untrained opera-

tives, and the logical result is neglect of those vital points which make the plant efficient.

In discussing the paper Prof. Geo. C. Whipple, of Harvard University, expresses his opinion to be that the safety of such plants must lie in the education of the low-salaried attendant and in the selection of such sources of supply that irregularities in operation will produce less disastrous results than in the case of larger plants where a higher grade of supervision is possible. To secure the better appreciation by the operator of the general principles of sanitation, and a better understanding of the work which a particular filter is capable of doing, the supervision of the state authorities should be not so much punitive as pedagogical.

Another remedy that has been suggested is the establishment of laboratories at convenient points to serve two or more small plants. Another is the employment of a consulting engineer in connection with operation as well as with installation. A third advocates a capable supervising engineer over several small systems on a co-operative working agreement.

The importance of efficiency in a plant of small capacity is as great to that community as it is in the case of any other plant. The question of placing water supply problems in every case in the hands of those who can deal scientifically with them has not received the attention it deserves. It is becoming more and more evident that the engineer must work in conjunction with the chemist and the bacteriologist in solving them. For small municipalities, therefore, there appears to be much of value in co-operation, each contributing toward the maintenance of such services.

PRESERVATION OF REFERENCES.

The engineer who is seeking a new position and who is fortunate enough to possess a valuable set of creditable and convincing references should consider them in the same light as he would any other property which is of value. The man who finds himself out of employment hastens, too often, to launch applications promiscuously, enclosing with them his original testimonials, and when they thus pass out of his possession they do not always return.

There is no advantage to be derived from a transmittal of the original references with letters of application for positions. Carbon copies fully convey the desired information, and do not entail a serious loss if they are mislaid. Moreover, an employer whose custom it is to place dependence upon such evidences of ability, training, character, etc., will see to it that they are bona fide before converting the applicant into an employee.

At first thought this may appear a trivial subject, but we are prompted to impart the advice by the experience of our Employment Bureau. Letters are being received continuously with the original references enclosed. Other applicants regret inability to furnish references owing to their having been previously lost or to their being out "on duty" in connection with another application. Frequently inquiries are received as to the safe keeping of these commodities.

The Canadian Engineer Employment Bureau keeps a permanent record of the professional standing and experience of its applicants for positions. Testimonials are preserved therewith in order to render the service more complete. Carbon copies are all that are required, it being understood that the original of each is in the proper possession of the applicant in order that he may have immediate recourse to them when an employer is disposed to consider original references only.

LETTER TO THE EDITOR.

THE BILLING'S BRIDGE (OTTAWA) DESIGN.

Sir,—It was not the writer's intention to enter into a controversy with anyone about the Billing's bridge at Ottawa. My only intention was to draw attention to the all too prevalent practice of building light floors on highway bridges. Mr. Henham, in his letter in *The Canadian Engineer* of February 19th, has made several statements which are so far removed from the facts that I feel obliged to correct them.

In the first place, I cannot agree with him when he uses $\frac{w\,l^2}{12}$ as the formula for the bending moment. I have never seen a specification of any authority which would permit such use. The general formula specified for continuous beams is $\frac{w\,l^2}{10}$, or, as some specifications state, "$\frac{8}{10}$ of the bending moment figured as a simple beam." (See clause 14, page 9, of the General Specifications for Concrete Highway Bridges of the Ontario Highway Board.)

In the second place, he states that "dividing the bending moment by the moment of resistance of the steel gives the sectional area required per ft. of width as 0.6 sq. in." I fail to understand what Mr. Henham means by this.

If the slab were designed properly, the moment of resistance of the steel would equal the moment of resistance of the concrete, and also the bending moment in the slab. This condition of design is obtained when the bending moment, M, = $108\ bd^2$ (where b = width of beam and d = effective depth), and when .78% of bd is the area of steel supplied. The above figures are only true when the compressive value of the concrete is assumed at 650 pds. per sq. in. and the tensile value of the steel is 16,000 pds. per sq. in. These are the most common values used. The deductions of these formulæ are to be found in any up-to-date text book on reinforced concrete. The bending moment as given by Mr. Henham is 3,500 ft. pds., or rather 4,200 ft. pds. when we use the formula $\frac{w\,l^2}{10}$. For this moment we require a slab of 6¼ inches effective depth.

In the third place, I cannot see how Mr. Henham can figure the truck load as 3,800 pds. per ft. of width. Taking his distribution of loading, i.e., 1.16 ft. × 1.83 ft. (the 1.83 dimension at right angles to stringers), this gives, in my opinion, a loading of $\frac{8{,}000}{1.16} = 7{,}175$ pds., and this load is uniform on the slab for width of 1.83 ft. The resulting bending moment is 4,630 ft. pds. and requires a slab of 6½ in. effective depth.

The loading Mr. Henham used is all right, the difficulty seeming to be in the design of the slab.

E. M. PROCTOR.

Toronto, February 24th, 1914.

DOMINION LAND SURVEYORS' ASSOCIATION.

The eighth annual dinner of the Association of Dominion Land Surveyors will be held at the Chateau Laurier, Ottawa, on March 3rd, at 8 p.m.

THE STRUCTURAL REQUIREMENTS OF THE TORONTO BUILDING BY-LAW OF 1913

BASED ON A REPORT SUBMITTED FEBRUARY 20th, 1914, TO JUDGE DENTON IN CONNECTION WITH THE INVESTIGATION OF THE CITY ARCHITECT'S DEPARTMENT, TORONTO.

By C. R. YOUNG, B. A. Sc., M. Can. Soc. C.E.
Assistant Professor of Structural Engineering, University of Toronto.

THE structural requirements of the Toronto Building by-law are in many respects not in conformity with good engineering practice. It is true that more conservative by-laws may be found, but these can in no sense be said to afford proper standards for the judgment of any building by-law under review. For the records of the best engineering practice one must turn to the published specifications of great engineering organizations, or of governments, or of railways, or to the writings of the leading structural engineers and to those of the more recent building codes which have been revised by structural experts or with their co-operation. It is entirely erroneous to regard building by-laws in general as expressive of good practice, for not only are they generally several years behind the times, but they have often been framed by one man and not infrequently show the handiwork of lay bodies who have the deciding voice in the inclusion or rejection of technical regulations. As compared, then, with what is best in modern construction, the Toronto by-law is faulty in many particulars.

No attempt has been made to present an exhaustive discussion of the shortcomings of the by-law. A few of the striking transgressions of good practice have been chosen for comment and an effort has been made to show in so far as possible, without undue labor, the practical outcome of the erroneous provisions.

FIREPROOFING OF EXTERNAL COLUMNS.

Sub-section 44, page 22.—An instance of undue severity is afforded in the requirement of *nine* inches of brickwork plus *one* inch of cement grout on the outside of iron and steel columns in external walls. No better proof of this is needed than the fixing in the same sentence of the protection for the inside of such columns at four and one-half inches of brickwork, or approximately one-half as much as for the outside, in spite of the fact that the temperature of a fire inside a building is much higher than that of a fire outside of it. If such were not the case, articles to be heated would be placed in an open fire rather than in a confined one.

A further admission of the sufficiency of four and one-half inches of brickwork for fireproofing is contained in the same sub-section, in specifying this thickness for the outer sides of beams or girders carrying the external walls. That there is no chance of a fire affecting steelwork situated 4½ inches from the surface of a brick casing is evident from the fact that the outer edges of the flanges of these beams and girders may project to within two inches of the outer surface. If 5½ inches of protective covering will not prevent a fire from softening the metal in external columns, certainly 4½ inches will not prevent the same fire from endangering the wall girders. With their collapse the lateral support of the wall columns would be removed and the columns would fail by buckling in the direction of the wall. The integrity of the building at one point thus depending upon 4½ inches of fireproofing, what reason is there for requiring 10 inches at a point subjected to the same destructive agency?

Perhaps the most convincing evidence of the sufficiency of 4½ inches of brickwork as fireproofing for external columns is seen in the adoption of a less thickness by the City of San Francisco in the revision of its building code after the great earthquake and fire and after having placed before it the conclusions of a special investigating committee of the American Society of Civil Engineers. For fireproofing all around such columns the requirement of the San Francisco code is but two and three-quarters inches of brick set in cement mortar, although the hazard in that city is much greater than in Toronto, due to the possible combination of earthquake and fire.

It is of interest to note further that Chicago, in its new building code, which was framed by a commission with large expert representation on it, permits four inches of brickwork all around external columns, while the City of St. Louis permits three inches.

The monetary loss involved in the excessive fireproofing of external columns would, for a 10-story building, say, 80x100 ft., amount to approximately $2,500.

CURTAIN WALLS.

Sub-section 44, page 23.—Since curtain walls carry only their own weight and usually for only one story in height, in certain cases it is absurd to require 14 inches of brickwork for them. In many industrial buildings where the curtain walls cover only 3 or 4 feet of vertical space immediately below the windows, the wastefulness of building in 14 inches of brickwork or plain concrete is apparent. In all buildings the space between the top of a window in one story and the bottom of a window in the next story above might safely be filled in with any material equivalent to wire glass in fire-resisting properties.

The contention that heavy brick walls are needed to prevent falling walls from breaking into a building is groundless, for no matter how heavy the curtain walls might be, falling walls could expose the interior of the building to flames by breaking through the windows. Nor is the relative smallness of the window areas any safeguard, for there is nothing to prevent the builder from constructing, and, indeed he often does construct, the whole space between columns from one floor to another of glass, but if he wishes to use brickwork at all it must be 14 inches in thickness. From this it follows that, according to the Toronto building by-law, one thickness of glass has a protective value as great as 14 inches of brickwork or plain concrete.

That a thickness of 9 inches of brickwork under and over windows is adequate should follow from the fact

that 9-inch walls are permitted by the by-law for severer conditions of loading than exist in curtain walls. Perhaps the best example of this is the use of 9-inch walls for the external, load-bearing walls of dwellings two stories in height. While curtain walls sustain only their own weight for one story of height, these bearing walls carry the entire weight of the floors and roof in addition to their own weight, for two stories in height.

A further abuse in the matter of curtain walls exists in the requirement that they shall be increased by 4½ inches in thickness below the uppermost 75 feet of the building and by an additional 4½ inches for each 60-ft. section below that. For the same story heights, curtain walls in the lower stories carry no more load than those in the upper stories and the thickening is no guarantee that falling walls may not break through into the building. Windows are allowed on any side of a building and may fill entire panels of wall space, as they very often do for the first story or two above ground.

The practical effect of this indefensible curtain wall specification is to increase the weight and size of the wall girders, wall columns and wall footings, to add a great deal of unnecessary brick, concrete or tile to the walls and to reduce the available floor space. Actual estimates show a financial waste for this reason alone in representative buildings running into thousands of dollars. For a 10-story building, say, 80x100 ft., the waste, neglecting the value of lost floor space, is from $7,000 to $10,000. In a memorandum submitted by Mr. A. H. Harkness, of Harkness and Oxley, consulting engineers, to Judge Denton in the recent enquiry into the City Architect's Department, it was shown that the cost of the Dominion Bank Building was increased by $14,200 by reason of the requirement that curtain walls shall be thickened below the top 75 feet of the building. Of this, $9,200 was for extra masonry and $5,000 for extra steel. Mr. Harkness also calculated that the loss in *annual* rental value because of the reduction in available floor space is $5,900. Capitalized at 6 per cent., this amounts to an investment of approximately $100,000. For the Canadian Pacific Railway Building, the cost of excess masonry was $6,150 and of excess steel $3,900, making in all, $10,050. The loss in annual rental value is $5,150, which when capitalized represents an investment of about $85,000. In the case of a large building in another city where the same antiquated regulations are in force the waste of steel alone involved in the thickening of curtain walls below the top 75 feet was 800 tons with a value of $45,000, not counting the cost of the masonry nor the value of the lost space.

SAFE LOADS ON BRICK WORK AND MASONRY.

Sub-section 19, page 44.—According to tests made in the University of Toronto laboratories, the average crushing strength of ordinary brick masonry laid in lime mortar is 67 tons per square foot, and when laid in cement mortar, 122 tons per square foot. In view of these results it is interesting to note the following safe loads per square foot specified for brick masonry in the Toronto by-law:

Kiln run bricks laid in lime mortar	4 tons
Ordinary brick laid in Portland cement mortar..	6 tons
Hard brick laid in lime mortar	7 tons

It is thus evident that in Toronto the average factor of safety required for ordinary brick laid up in lime mortar is 17, and for ordinary brick work with Portland cement mortar no less than 20. For walls, piers or other like supports a factor of safety of over 10 or 12 is uncalled for and its requirement results in a great waste of material.

A striking commentary on the lowness of the allowable pressures on brick masonry is afforded by comparing them with the following permissible loads per square foot on soils established by the by-law:

Gravel and coarse sand, well cemented	8 tons
Dry, hard clay	4 tons
Sand, compact and well cemented	4 tons

From the above two tables it is evident that a well compacted gravel or coarse sand is considered to be capable of sustaining more load than any one of the three grades of brick masonry mentioned and twice as much as kiln run bricks laid in lime mortar.

It is of interest to note, too, that with respect to the load that would result in dangerous, crack-producing settlements, the factor of safety involved in the above permissible soil pressures is from 2 to 3, while the factor of safety required on brick masonry is from 17 to 20.

A study of the available records of tests of brick masonry indicates that the specified safe loads on brick work might, with perfect security, be increased 33 per cent., and still allow a factor of safety of at least 12. The waste in brick piers, as at present constructed, is therefore 33 per cent.

The safe pressure on walls and piers of concrete is also much too low and should be increased.

CAST IRON COLUMNS.

Section 16, page 74.—In view of the results of tests on full-sized cast iron columns, and the large element of uncertainty attending their manufacture and use, the safe loads specified for these columns in the by-law are undoubtedly excessive. A factor of safety of less than four, which the by-law permits in the case of the most heavily loaded columns is manifestly insufficient when it is remembered that with the far more reliable material, structural steel, the factor of safety demanded is four. No acknowledged authority known to the writer sanctions a factor of safety of less than 5 for cast iron columns and for this reason the safe loads allowed by the by-law should be reduced for certain columns by over 20 per cent.

PLATE GIRDERS.

Sub-section 4, page 77.—The provisions of the by-law respecting plate girders are not in accordance with good engineering practice. In order to satisfy them, girders must be made considerably heavier than would be required for the support of the same loads in most of the railway and highway bridges of the country. Thus, a plate girder constructed according to either the specifications of the Canadian Pacific Railway, the Grand Trunk Railway, the Canadian Northern Railway, the Dominion Government, the Ontario Government, or the Canadian Society of Civil Engineers would not be acceptable for use in a building in Toronto. The absurdity of this is still more apparent when it is remembered that a bridge girder must withstand large and uncertain stresses due to impact and vibration and is subjected to rapid corrosion from moisture and locomotive gases, while a building girder carries quiescent loads and is but little exposed to corrosion. Another remarkable fact is that plate girders in bridges built by the Works Department of the City of Toronto, and conforming as they do to the above-mentioned authoritative specifications, would not pass the city building by-law, and would be regarded as unsafe by the City Architect's Department. On the other hand, if all the city bridges are safe, there is an

unpardonable waste of material in the girders which the by-law requires to be used in buildings.

Some indication of the unreasonable exactions of the by-law in this particular may be had from the following estimates made by the writer. A girder built in accordance with the by-law to carry a load of 100 tons would, according to the specifications of the great railways, the Dominion and Ontario Governments, the Canadian Society of Civil Engineers and the Works Department of the City of Toronto, be entirely safe for a load of 122½ tons. A girder designed for 200 tons according to the by-law would be safe for a load of 238½ tons. To put the matter generally, girders designed in conformity with the Toronto building by-law will carry with the factor of safety demanded by the railways, for example, from 17 to 35 per cent. more than they are at present permitted to carry.

The waste of material involved in following such an antiquated plate girder specification varies with the capacity and span of the girder but lies normally between 8 and 10 per cent. Plate girders as used in the buildings of Toronto thus cost from 8 to 10 per cent. more than they should. In the new Dominion Bank Building at the corner of King and Yonge Streets, $1,200 was absolutely wasted on this one item alone. In the new Royal Bank Building the corresponding loss will be $1,400, in the Toronto Technical School it will be $2,100, and in the new Methodist Book Room it will be about $2,200. From these, and other facts it is apparent that not less than $25,000 is expended every year in putting excess material into plate girders, which, as far as use is concerned, might quite as well be thrown into the sea.

SAFE LOADS ON TIMBER COLUMNS.

Section 18, page 80.—The safe loads on timber columns are much lower than are sanctioned by almost any good specification that might be named, and do not correspond at all to the results of actual tests. For example, a long-leaf yellow pine column 12 x 12 ins. and 15 ft. long and which would not be allowed to carry more than 52 tons by the Toronto by-law would be considered entirely safe for a load of 61 tons in Boston, Buffalo or Minneapolis or a load of 64 tons in Chicago, or a load of 70 tons in Baltimore or in a structure built by the Works Department of the City of Toronto 65 tons, or in any structure built in accordance with the requirements of either the Dominion or Ontario Governments a load of 68 tons. It is not remarkable that a column which a Toronto contractor must put into a building to carry a certain load, would, if put into a civic bridge in the same city, be allowed to carry a load of 24 per cent. greater, or if put into any bridge sanctioned by either the Dominion or Ontario Governments a load 31 per cent. greater? And this is not by any means the worst case, for with columns of greater slenderness the exactions of the by-law are still greater.

The practical result of this is that the cost of the columns of mill construction buildings, is on an average 25 per cent. greater than it should be.

FLOOR LOADS.

Section 23, page 86.—The specified live loads for which floors are required to be designed are in a number of cases greater than are at all likely to occur in the life of the buildings concerned, and in the interests of economical construction some reduction in such loadings should be made. A careful comparison of the prescribed loads set forth in the by-law with the results of actual investigations, with recent authoritative specifications and with such building codes as have been revised recently, indicates excessive requirements in the Toronto by-law. Two instances will suffice to show the need of careful consideration of the present specified loadings.

Paragraph d, page 87.—It has been clearly shown by careful determinations of the maximum loads on the floors of office buildings, that the loads in the offices themselves, above the ground floor, will ordinarily never exceed 40 to 50 pounds per square foot. A thorough investigation of this kind was made by Messrs. C. H. Blackall and A. G. Everett in three large office buildings in Boston. For each room the weights of the furniture and contents and of the greatest number of people known to have been in it at any one time were taken, and the greatest load thus found in any one office was 40.2 pounds per square foot. In only 12.4 per cent. of the offices was the maximum known floor load in excess of 25 pounds per square foot and in only 26 per cent. was it over 20 pounds per square foot.

In the light of these and other observations which might be cited, a floor load in offices of 75 pounds per square foot as is required in Toronto appears to be extravagant and should be reduced to 50 pounds per square foot. Partitions should be considered as an additional load.

As an instance of the adoption of rational floor loads for office buildings, the recently revised building code of the City of Chicago places the loads at 50 pounds per square foot *for all floors and corridors* with partitions extra.

Paragraph f, page 87.—A consideration of the character of the loading on school room floors and of the conditions existing in such buildings leads to the conclusion that 75 pounds in rooms and 100 pounds in corridors and lobbies are excessive live loads. A mixed throng of children averaging, perhaps, 75 pounds each in weight cannot impose upon a floor any such load as a throng of adults averaging 150 pounds each. Investigations will show that while children weigh on an average half as much as adults they occupy two-thirds as much space, and therefore the intensity of loading due to a throng of children should not be over three-quarters of that due to a throng of adults. If, then, a load of 75 pounds per square foot represents, as the by-law assumes, the probable weight of a mixed crowd in the main entrance halls of hotels, apartment houses, tenements and boarding schools and in the corridors and halls of office buildings, surely it should be an adequate allowance for the live load in the corridors and lobbies of schools where the typical crowd will weigh 25 per cent. less. Nevertheless, the by-law requires the latter to be figured for 100 pounds. In the school rooms, where the seats are generally fixed, a load of three-quarters of that specified for the corridors and lobbies, or, say, 60 pounds per square foot should be entirely adequate.

The propriety of these loads for schools is evidenced by the fact that the framers of the new Chicago code fixed the maximum loads for the assembly halls, corridors and stairs of schools at 75 pounds per square foot and for all other parts 40 pounds per square foot.

REDUCTION OF LIVE LOADS ON GIRDERS.

Since a girder can receive its maximum load only when the beams which it supports are fully loaded, it follows that a much larger area must be covered for the maximum load on a girder to arise than it is necessary to cover for the production of the maximum load on a floor beam. In an average case these areas are as three

to one, and for many floors the area to be covered with the stipulated floor load before a girder can receive its maximum stress is six or seven hundred square feet. Manifestly, the probability of an area of this size being *entirely* covered with the full floor load is very small. Even in the case of storage warehouses, where the probability is greatest, a considerable percentage of floor space must be left for aisles. The requirement of the Toronto by-law that girders must be figured for the same floor load per square foot as beams are figured is therefore entirely indefensible.

The completely covered proportion of the area sending load to a girder is variously estimated. Mr. Gunvald Aus, the consulting engineer on the world's greatest building—the Woolworth Building—favors making it two-thirds. A considerable number of cities fix it as substantially less than the full area. Chicago, Boston Philadelphia, Pittsburgh, Cleveland, St. Louis and San Francisco may be cited as instances. The reduction fixed by the building codes of these cities for most types of buildings ranges from 10 to 20 per cent., with an average of 15 per cent. That is, girders in most buildings, according to the codes mentioned, would be figured for only about 85 per cent. of the full possible floor load. The only kind of building for which the full floor load is required to be figured in the cities named is the warehouse or heavy mercantile building, and not even for these in all cases. The writer is thoroughly convinced that the calculation of girders for more than 85 per cent. of the full live load, except in the case of warehouses, is an extravagant and unnecessary procedure.

The practical result of the severe requirements of the present by-law with respect to girders has been estimated by the writer for different types of buildings and is as follows: For office buildings the increased cost of girders is approximately 4½ per cent.; for stores it is about 5 per cent.; while for factory buildings it is about 5½ per cent. The effect upon the cost of the beams, girders and columns is to increase it by from 1½ to 2 per cent. For a building in which these structural parts cost $100,000, the waste involved by this regulation of the specification alone is from $1,500 to $2,000.

REDUCTION OF LIVE LOAD ON COLUMNS.

Section 12, Sub-section 1, page 38.—Since the live load borne by a column in any story is derived from an area very large in comparison with the area tributary to either a floor-beam or a girder, a smaller floor live load should be used for figuring columns than for figuring floor-beams or girders. Admission of this principle is made in the by-law, but the probable maximum load, particularly for columns a long way down from the top of the building, is greatly overestimated.

Thus, to illustrate, in a typical office building, a column in the 12th story down from the roof must be figured for 76 per cent. of the maximum loads to be carried by the roof and all the floors above while most structural engineers consider 80 per cent. of the full specified live load as adequate for girders and even many of the building by-laws require only 85 per cent. of the full floor load for girders. The absurdity involved is most evident when it is remembered that the area which must be covered for a *full* load on the column mentioned is 24 times that which must be covered for a full load on a girder. Surely if not more than 80 or 85 per cent. of an area delivering load to a girder is likely to be fully loaded, an estimate of a full load on 76 per cent. of an area 24 times as great is altogether illogical and unsound.

The unreasonable demands of the by-law in this particular may be shown in still another way. For the column in the twelfth story down from the roof, after allowing for a full snow load on the roof and the weight of furniture, office equipment, safes, etc., on all floors, no less than 5,000 people would, in an average case, need to be massed about this column on the area contributing load to it in order to realize the load for which the Toronto by-law would require the column to be figured. The writer has estimated that even in a building with first-class elevator equipment it would take 3½ hours to distribute these 5,000 persons to the various floors, with none descending.

While the exacting character of these regulations respecting column live loads is less striking for columns nearer the roof than for the one forming the subject of the illustration, the waste involved is considerable, and what is more, entirely indefensible.

Corroboration of the conclusions expressed above may be had in the investigations of Messrs. Blackall and Everett, to which reference has already been made. In the three office buildings examined, while the greatest live load found in any room on any floor in any building was 40.2 pounds per square foot, the average of the maximum loads for all floors did not exceed 17 pounds per square foot in any one of the three buildings. It thus appears that the average maximum for *all* the floors is less than one-half of the maximum probable load on any one floor, and that columns in the lower stories of buildings, except storage warehouses, need not be designed for more than one-half of the specified maximum loads on the floors above. The proportion should, of course, gradually increase to 100 per cent. as the roof is neared.

That a much greater reduction of live loads on columns than is permitted in Toronto is sanctioned by good practice may be gathered from a study of the opinions and specifications of eminent structural engineers, and of the most recently revised building codes. Some years ago a notable paper on "The Structural Design of Buildings" was presented to the American Society of Civil Engineers by Mr. C. C. Schneider, one of the three engineers who are rebuilding the Quebec Bridge, and from the discussion of this paper by the ablest structural engineers of the continent it was shown that engineers are unanimous in their approval of live load reductions for columns much greater than are allowed by the Toronto by-law. This opinion was embodied in the authoritative "General Specifications for the Structural Work of Buildings" subsequently published by Mr. Schneider. Turning to the building codes, it is found that Chicago, Boston, Baltimore, St. Louis, Minneapolis, Providence, and San Francisco all allow greater reductions than are permitted in Toronto.

As a result of the severity of the Toronto by-law in the matter of column live loads the cost of columns in buildings over five stories in height is increased from 3 to 10 per cent. and the effect on the cost of the beams, girders and columns of the building is to increase their cost from three-quarters of one per cent. to two per cent. For a building in which these parts cost $100,000 for this particular item alone the waste involved would be from $750 to $2,000, depending on the number of stories.

REINFORCED CONCRETE CONSTRUCTION.

Pages 154 to 183.—Objection is made to the provisions of the present by-law respecting reinforced concrete on the following general grounds:

(1) The strength and reliability of this form of construction is underestimated.

(2) The necessary assumptions of design are, in a number of cases, not in accordance with those adopted by the best authorities.

(3) The regulations are incomplete.

That the section of the present by-law under discussion is not in accord with the best engineering practice of the day might easily be ascertained by any impartial technically-trained person. To do this it would merely be necessary to consult the recent literature of reinforced concrete, for example, the so-called Joint Committee Report, the most authoritative statement yet made in America of what constitutes good practice in reinforced concrete design and construction. This document is the result of the deliberations for a period of ten years of a Joint Committee formed of committees of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association and the Association of American Portland Cement Manufacturers. So satisfactory and manifestly sound are the regulations of this report that other large technical organizations have adopted almost identical specifications. At the present time the Canadian Society of Civil Engineers has in course of preparation a specification for reinforced concrete agreeing, in the main, with that of the Joint Committee.

With the authority of the great engineering societies behind them many cities of the United States have quite naturally adopted regulations for reinforced concrete closely conforming to the recommendations of the Joint Committee Report. In one case a state—Pennsylvania—has taken such a step.

In judging the character of the Toronto building by-law, with respect to the regulations of reinforced concrete construction, it is possible, therefore, to make a comparison with the provisions of a number of other building by-laws, with the assurance that the relation of the Toronto by-law to good practice will thereby be fairly disclosed. Such a comparison shows that the Toronto regulations are much more exacting than those adopted by most of the cities that have recently revised their building codes. New York, Chicago, Pittsburg, Detroit, Cleveland, St. Louis, and Minneapolis approve as perfectly safe reinforced concrete structures which, in some cases, are considerably lighter than those permitted in Toronto, and these cities are by no means the only ones that might be named.

It is of interest to note, also, that reinforced concrete structures built according to the specifications of the Ontario Government and the Works Department of the City of Toronto are considerably lighter than those which would result if the Toronto building by-laws were followed.

On account of the difficulty of estimating the relative severity of reinforced concrete specifications by comparing them, point by point, the writer has made careful designs and estimates of quantities and costs for an interior panel of a reinforced concrete building in accordance with the Toronto building by-law and three other specifications. The panel and its loading were so chosen that as many as possible of the important provisions of the various specifications would be brought into operation. To effect this a panel 21 x 21 feet, with beams heading into the girders at the third points and carrying a superimposed load of 250 pounds per square foot, including the floor finish, was adopted. As a result, it is believed a fair indication of the average requirements of each specification is brought out.

The three specifications chosen for comparison, in this way, with those of the Toronto by-law were the Joint Committee Report, and the recently-enacted reinforced concrete regulations of the New York and Chicago building codes. More reinforced concrete structures in America are designed to the Joint Committee regulations than to any other, or perhaps to any half-dozen other specifications, and because of the size of New York and Chicago their regulations should be regarded as possessing some weight, particularly since they represent very recent work on the subject. Taking the Joint Committee design as the standard, and letting quantities and costs for it be represented by 100 for each item, the following statement represents the comparative results of actual detailed designs, the assumed unit costs being the same in all cases:—

Comparison of Quantities and Costs for a Typical Floor Panel.

Specification.	Volume of concrete.	Weight of steel.	Area of forms.	Costs.
Joint Committee, 1913.	100	100	100	100
Chicago, 1911	94.4	101.1	98.7	97.9
New York, 1911	95.1	109.0	95.8	100.5
Toronto, 1913	116.0	99.9	105.1	109.3

It should be pointed out that this table does not indicate the full measure of severity of the Toronto regulations. The figures given do furnish a fair comparison of the cost of reinforced concrete floors and one tier of columns, but when the effect of increased load on the columns below and on the footings is taken into account, the much heavier dead load applied to the columns at *each* floor results in further increased quantities and costs. It is, therefore, very close to the truth to say that the exacting nature of the provisions of the Toronto Building By-law with respect to reinforced concrete, apart from all other considerations, makes the cost of the reinforced concrete work in buildings at least 10 per cent. more than it should be. In this city during the course of one year there is probably a million dollars worth of such work done, and on this basis at least $100,000 is taken out of the pockets of owners to no useful purpose whatsoever. If the effect of other objectionable sections of the by-law on the reinforced concrete portions of buildings be considered, the waste is very much increased.

On the ground of incompleteness a number of criticisms might be made of the sections of the by-law relating to reinforced concrete. One of these is prompted by the fact that no specification whatever is included for a form of reinforced concrete construction which has found long and satisfactory use in the United States, and which possesses marked advantages for long spans and heavy loads. This is the girderless floor or flat-slab type of construction. As a result of the omission of any reference to it in the by-law, and the absence of definite regulations concerning it, little effort has been made to introduce the system here, to the financial loss of those who erect reinforced concrete buildings.

THE PRACTICAL OUTCOME OF THE DEFECTS IN THE PRESENT BY-LAW.

One obvious result of the exactions of the present by-law is the high cost of building. In steel construction, experience has shown that the *total* cost of buildings is from 3 to 10 per cent. more than it should be. Reinforced concrete buildings cost at least from 5 to 15 per cent. more than they would if designed to a reasonable and at the same time perfectly safe specification. The waste involved in mill construction buildings is from 5 to 10 per cent. of the total cost. Taking all classes of buildings into consideration, it is on the side of safety to say that *there is an annual waste in the construction of buildings in Toronto of at least three-quarters of a million dollars.*

Other results which follow the high cost of building are the location of industries outside of Toronto and the limitation of building projects. Of these the Citizens' Committee, which made a thorough study of the defects of the by-law in 1911, found a number of instances, some of which were recorded in the Memorial addressed to the Mayor and Board of Control in May, 1911.

A most deplorable result of the present objectionable by-law is the premium which, in effect, it places on non-fireproof construction. Under average conditions outside of Toronto fireproof buildings can be built for from 10 to 15 per cent. more than mill construction buildings, but in Toronto the difference in cost is from 15 to 20 per cent. Rather than pay this, therefore, owners prefer to erect non-fireproof buildings and pay higher insurance rates.

SHIPBUILDING IN 1913 IN GREAT BRITAIN.

The following table and comparisons showing the general progress in shipbuilding in 1913, and particularly the advance shown in the United Kingdom, are extracted from an article of considerable length in *The Contractors' Chronicle*.—

"For the year 1913 record productions are shown in the leading shipbuilding centres of the United Kingdom. Remarkable progress has been made in other countries, but British yards continue to provide their old-time proportion of the world's tonnage. Returns of vessels launched in 1913 show a total in number of 3,936, and in measurement of 4,267,166 tons, while there is recorded a total of 4,924,799 i.h.p. In all these figures there are increases as compared with 1912—in number of vessels 325, in measurement nearly 500,000 tons, and in machinery over 677,000 i.h.p. In the United Kingdom there were launched 1,474 vessels of 2,263,933 tons, and there were manufactured marine engines of 2,661,260 i.h.p. These figures show increases over those of 1912 of 120 vessels, 183,762 tons and 388,994 i.h.p. Of these increases the credit for the additional number of vessels is due wholly to England, and that for the increased tonnage and horse-power principally to Scotland. England produced 133 vessels, 95,071 tons and 135,460 i.h.p. more than in 1912, while Scotland produced 15 fewer vessels, but 121,523 tons and 233,485 i.h.p. more, while Ireland turned out 2 vessels more, 32,832 tons less and 20,050 i.h.p. more than in the previous year. Comparing the work of the United Kingdom with that of other nations, we find that the United Kingdom produced just about one-third of the total number of vessels, nearly 320,000 tons measurement more than all other countries combined, and nearly 420,000 horse-power more. The apparent discrepancy in the lower number of vessels is explained of course by the fact that the vessels built in the United Kingdom are of much greater average size than those built abroad. The following table shows briefly the shipbuilding work of the world for the years 1913 and 1912:—

	1913.			1912.		
	Ves.	Tons.	I.H.P.	Ves.	Tons.	I.H.P.
England	945	1,322,306	1,300,445	812	1,227,235	1,263,086
Scotland	505	800,711	1,148,[illegible]5	5[illegible]	688,188	914,740
Ireland	24	131,016	11[illegible],500	22	164,748	9[illegible],540
U.K. totals	1,474	2,263,933	2,661,260	1,354	2,080,171	2,272,[illegible]66
Dominions	280	59,025	20,662	208	36,578	17,022
Foreign	2,182	1,944,158	2,242,877	2,049	1,648,310	1,957,606
Grand totals	3,9[illegible]6	4,26[illegible],11[illegible]	4,924,799	3,611	3,765,059	4,24[illegible],794

By March [illegible] the new factory built [illegible] Peterborough, Ont., by Henry Hope and Sons, Limited, will be ready for the manufacture of wrought steel sash, roof glazing and skylights. The building is all brick and steel, 200 feet long by [illegible] feet wide, and shows well the adaptability of steel sash and saw-tooth roof to the modern factory. Alex. Young, the superintendent and manager of the company, states that the machinery for this plant was specially designed, and embodies the latest improvements. The factory is fitted throughout with carrying tracks and travelling cranes.

REPORT OF THE TORONTO RAILWAY COMPANY FOR 1913.

Operation during 1913 was most favorable, according to the 22nd annual report of the Toronto Railway Co. The gross earnings of the company for the past year were \$6,049,018; charges for operating, maintenance, etc., \$3,123,308; and net earnings, \$2,925,710. From the net earnings was deducted the sum of \$2,158,472, distributed as follows:—Dividends, \$879,958; and bond interest, etc., \$188,806.

The gross passenger earnings show a big increase, these earnings amounting to \$5,980,695, compared with \$5,367,502 for 1912, an increase of \$613,193. The various charges against these earnings for operating, maintenance, etc., amounted to \$3,123,308 or 52.2 per cent. of the passenger earnings. The payments made to the city of Toronto shown in the report amounted to the sum of \$1,089,708, which, when compared with the payments made during the previous year, shows an increase of \$147,659.

Heavy expenditures on capital account were made amounting to \$1,064,857. In addition to various extensions and improvements to certain of the company's shops, car houses, etc., the following buildings were erected:—A storage battery building was completed in connection with the Harrison Street sub-station; a sub-station (No. 4) was erected in Queen Street East, opposite Logan Avenue; and a paint shop was built on Queen Street East on property running from Queen Street to Eastern Avenue. Large expenditure was made in the installation of a storage battery plant in the Harrison Street building, in the construction of additional rolling stock and the purchase of electrical equipment for same and in the extension of the track and overhead system in different sections of the city.

The growth of the business of the company since 1903 is clearly shown in the following table:—

	1903.	1913.
Gross income	\$2,172,087.85	\$6,049,018.92
Operating maintenance, etc.	\$1,200,823.39	\$3,123,308.55
Net earnings	\$ 971,264.46	\$2,925,710.37
Passengers carried	53,055,322	151,236,925
Transfers	18,654,344	63,083,118
Percentage of charges, etc., to passenger earnings	55.3	52.2

Compared with 1912 also, all these items show a large increase, with the exception of the percentage of charges to passenger earnings, which decreased 1.2 per cent. Dividends at the rate of 8 per cent. per annum were paid during the year.

The gross earnings of the Toronto and York Radial Railway Company amounted to \$584,490, compared with \$492,922 for the previous year, an increase of 18.5 per cent.

CONSIDERATION OF ROADS IN TOWN PLANNING.

A road conference was held in London, England, late in December, which was called to consider the necessity in town planning schemes of co-operation between the various local authorities and the central authorities for the purpose of suitable and proper roads. Speaking on this subject, Mr. Burns said that there were signs in every direction that popular taste, executive desire, and administrative necessity were all tending toward a greater grasp of the road and town planning problem. Now that the town planning act was available for roads, as well as for town planning, they ought to utilize the general sentiment and, in each particular case, unite the central and local authorities, so as to secure the best results. This was already being done in England and Wales, as was proved by the fact that 200 local authorities were town planning, whilst in Greater London there were 80 local authorities of whom 38 were at work on different stages of town planning and road making. To further local co-operation in the carrying out of these schemes of town planning and road making, Mr. Burns proposed that first of all local conferences of the authorities of adjoining districts should be held at once. To these conferences should fall the duty of deciding the character, the varying methods, and, above all, the alignment of local roads, and the cost and its division among the various authorities interested. To these local authorities co-operating among themselves would be given help, guidance, advice and perhaps some money for individual schemes from the central authority.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

CONTENTS.

BOOK REVIEWS.

Elementary Graphic Statics.—By J. T. Wight, A.M.I.Mech.E., Lecturer in Machine Design, Heriot-Watt College, Edinburgh: published by Whittaker and Co., London, E.C. and New York, N.Y., 227 pp., 5 ins. x 7 ins.: cloth: 135 illustrations: price, $1 net.

This is a text book specially written for students in search of a working knowledge of the application of graphical methods to the solution of the simpler problems met with in engineering and building construction. The writer presents the subject clearly and in language readily understandable. The symbols used are those almost universally adopted. The illustrations are recognized as having been carefully and specially prepared in connection with the points under discussion, while the subject matter of each chapter is well supplemented by carefully selected examples to be worked by the student.

The book begins with a very elementary treatment of the graphic representation of forces, proceeding to their composition and resolution. Chapter 3, deals with simple, practical problems of the foregoing, such as loaded platforms, frames, tripods, cranes, etc. Moments, followed by bending moment and shearing force diagrams, precede an entrance into the investigation of loads and pressures on beams, roofs, girders, retaining walls, etc. Chapter 9, takes up the study of centre of gravity and moments of inertia.

It is a book not to be merely read, but to be carefully studied with continual reference to frame and stress diagrams contained therein, and the conscientious working of examples. Thereby students can readily acquire a competent knowledge of elementary graphical solutions.

Economics of Interurban Railways.—By Louis E. Fischer, Consulting Engineer, Missouri; published by McGraw-Hill Book Co., New York and London; 116 pp.; 5 ins. x 7½ ins.; cloth; price, $1.50 net.

The lack of data of actual and proven information so compiled as to be useful to communities where electric interurban railways are being promoted or contemplated, evidently prompted the writer to produce a resumé of the actual economic results which have been obtained from the operation of such railways existing in the United States.

The subject is treated in the following manner:—

Chapter 1, Inception and Development of Electric Traction; Chapter 2, Classifications and Definitions; Chapter 3, Operating Revenue; Chapter 4, Operating Expenses; Chapter 5, Cost of Construction; Chapter 6, Economic Relations of the Foregoing; Chapter 7, Conclusion; remarks based upon the statistics analysed. It brings out the fact that there are a great number of electric interurban railways now in operation that are not the commercial successes they are generally considered to be, due probably to an insufficient study of existing conditions and factors underlying success.

The author assumes the classification of operating revenues and expenses, etc., as prescribed by the Interstate Commerce Commission for electric interurban railroads; and from the operating records that are available, he selects indiscriminately a few cases, analysing them and making deductions respecting the relations of the various factors.

The book is well written and easily understood. A few ungrammatical expressions exist, for example, "there are such a variety of local conditions" is used on page 13. Again there are slight inaccuracies in numerical computations in one or two instances, but not of such a magnitude as to alter the potency of the conclusions drawn therefrom.

Those who are seeking to comprehend the fundamental conditions essential to an economically successful road, as well as investors trying to discriminate between fundamentally good or bad electric interurban railway securities, will find this book of great value and assistance.

Questions and Answers Relating to Modern Automobile Design, Construction Drawing and Repair.—By Victor W. Page, M.E.; published by the Norman W. Henley Publishing Co., New York City; 622+32 pages; 4¾ ins. x 7¼ ins.; cloth, price, $1.50.

As the title implies, the subject matter of this book is arranged in the form of lessons consisting of questions and answers. From very elementary topics the reader is brought progressively into the intricate study of features of design and construction. Every mechanical contrivance that has come into common use in automobile building seems to have been included. The numerous illustrations convey the impression that they are largely from the catalogues of prominent manufacturers, which the writer acknowledges at the outset.

Engineers who resort to the automobile in business or for pleasure will find this book worth many times its price for the suggestions it contains respecting the design, construction and repair of cars, equipment and accessories, as well as for the useful instructions respecting operation. The book is very carefully indexed and its diagrams are clear and not excessively reduced, many of them being in the form of inserts.

Cranes and Hoists.—By Hermann Wilda, translated from the German by Chas. Salter; publishers, Scott Greenwood and Son, London, E.C.; 158 pages; 399 illustrations; 4 ins. x 7 ins.; cloth; price, $1.

This book is a useful compilation on lifting tackle of all kinds. It is published in two chapters, the first being a study of the mechanics and theoretical design of chains, ropes, pulleys, hooks, brakes, bearings, couplings, etc., and the second being descriptive of the types of cranes and hoists ordinarily used. Although the book appears to be over-illustrated, and some of the illustrations are complicated owing to over-reduction, they are quite necessary, nevertheless, for a clear understanding of the text, the greater part of which is presented in a most condensed form, the trans-

lator apparently endeavoring to produce in a small [illegible] the information to which one often finds a book approximately twice the size devoted.

The calculations that are submitted may not be found of value unless a thorough study of the mathematics connected with each is made, and engineers in general might be disposed to consider the book as unbalanced both with regard to illustrations and mathematical computations. It is a subject nevertheless which demands a thorough treatment in the matter of design, and those who are interested in the construction of mechanical contrivances for the lifting and handling of all kinds of industrial machinery and apparatus will find the volume one remarkably concise and carefully translated.

Autogenous Welding, Oxy-Hydrogen and Oxy-Acetylene.—By R. Granjon and P. Rosenberg, translated from the French by D. Richardson, A.M.I.M.E., Lecturer on the subject at the Northern Polytechnic; published by Chas. Griffin and Co., Limited, Strand, London; 234 pp. + 12 pp. advt.; 257 illustrations; 6 ins. x 9 ins.; price, $1.25.

"Autogenous welding is certainly the one process of construction and repairs that requires, from top to bottom of its application most reflection, intelligence and conscientiousness."—Author's preface. This handbook on the use of oxy-hydrogen and oxy-acetylene blow pipes contains a great deal of practical information for the welder upon the scientific use of his apparatus and the most approved methods of operation. It presents a reliable, though simple, technique in the art of autogenous welding and is notable for the omission of intricate scientific considerations relevant only to a more advanced study of the subject. The fundamental principles serving as the base for all applications of the science are well brought out. The authors do not claim that it is in any way perfect or final as the science itself is only in its infancy. A very valuable feature of the book is its concluding chapter which deals with the cutting of iron and steel with the blow pipe and an oxygen jet.

The book will be warmly welcomed by engineers and manufacturers interested in the process, there being no other work on the subject in the English language at present.

PUBLICATIONS RECEIVED.

Cement Gypsum and Lime.—The 1914 directory of manufacturers. A 214-page leather-bound pocket directory, published by the Cement Era, Chicago, Ill.

Gas Analysis.—Errors due to assuming that the molecular volumes of all gases are alike. Issued by the United States Bureau of Mines, Washington. 16 pages.

Report of the Department of Public Works.—A 1913 report of the Minister of Public Works, Ottawa, including reports of Deputy Minister, Chief Engineer, Chief Architect, Accountant, etc.

Metal-Mine Accidents.—A booklet of statistics compiled by A. H. Fay for the United States Bureau of Mines, covering accidents of this nature which occurred in the United States during 1912.

Magnetite Occurrences Along the Ontario Central Railway.—By E. Lindeman, M.E., issued by Mines Branch, Department of Mines, Ottawa. 24 pages; illustrated by 9 photographs and 20 maps.

Clay and Shale Deposits of the Western Provinces.—Report by Heinrich Ries and Joseph Keele.; Geological Survey, Department of Mines, Ottawa. Memoir No. 25, 108 pages, fully illustrated.

Geology of the Coast and Islands Between the Strait of Georgia and Queen Charlotte Sound, B.C.—By J. Austen Bancroft. Issued by the Geological Survey as Memoir No. 23, Department of Mines, Ottawa. 150 pages; illustrated; additional maps.

Montreal Water Works.—By F. Clifford Smith. A 54-page illustrated booklet containing a historical description of the development of the Montreal water works system from the year 1800 to 1912.

Railway Statistics.—A report for year ending June 30th, 1913, of A. W. Campbell, Deputy Minister Department of Railways and Canals, Ottawa, compiled from returns furnished by the various railway companies of Canada.

Basins of Nelson and Churchill Rivers.—Memoir No. 30, Geological Survey, Department of Mines, Canada. Geological report by Wm. McInnes on the area west of Hudson Bay, embracing part of the Province of Saskatchewan and part of the Northwest territories.

Minutes of Proceedings of the 33rd annual convention of the American Waterworks Association, held at Minneapolis, Minn., June 23rd, 27th, 1913; 210 pp., 6 ins. x 9 ins.

Transcontinental Railway.—The 9th annual (1913) report of the National Transcontinental Commissioners setting forth the receipts and expenditures in connection with the eastern division and containing the reports of the Chief Engineer and District Engineers.

Variations in Results of Sieving with Standard Cement Sieves.—Technologic paper No. 9, of the United States Bureau of Standards, outlining the variations in determinations of fineness of cement that are liable to occur when the standard routine method of sieving is used.

Metallurgical Coke.—By A. W. Belden, United States Bureau of Mines. Containing statistics of coke production in the United States, development of methods, preparation of coal or coking, fiscal properties and chemical composition of coke, by-products, etc. 148 pages illustrated.

Topographical Surveys Branch.—Annual report of the Surveyor-General of Dominion lands for the year ending March 31st, 1912, containing reports of surveyors, maps, profiles and illustrations. The report contains, as appendix No. 51, an article descriptive of the copying camera of the Surveyor-General's office.

Austin Brook Iron Bearing District, New Brunswick.—A 16-page bulletin compiled by Einer Lindeman, M.E., for the Mines Branch, Department of Mines, Ottawa, covering the work done in, and the general characteristics of the iron-bearing district of Austin Brook, New Brunswick. Illustrated by charts and photographs, supplemented by maps.

Tests of Permissible Explosives.—By C. Hall and S. P. Howell, United States Bureau of Mines. A 310-page book with illustrations and tables describing apparatus and methods for physical tests of explosives and results. It contains a classification also of permissible explosives, their rates of detonation and useful suggestions in selecting explosives.

Coal Washing in Illinois.—Bulletin No. 69, Engineering Experiment Station, University of Illinois. A 108-page booklet by F. C. Lincoln, Assistant Professor of Mining Engineering, describing the purification of coal by mechanical treatment with water; containing sections devoted to history of coal washing, impurities in coal, crushing and sizing, methods of washing, arrangement and results.

Electrolysis in Concrete.—Technoligic Paper No. 18, United States Bureau of Standards, Washington. A 140-page treatise by E. B. Rosa, B. McCollum and O. S. Peters; containing investigations relating to the nature and cause of the phenomena resulting from the passage of electric currents through concrete; possibilities of trouble from electrolysis in concrete structures under practical conditions; protective measures, and conclusions.

Report of Transit Commissioners, City of Philadelphia.—A comprehensive report, dated July, 1913. Volume 1, of 267 pages, recommends a rapid transit system giving general

design, estimates, present and prospective traffic, time saved by rapid transit, estimate of income account, effect of rapid transit on assessed values, examples, with statistics, in other cities; population and housing statistics, etc. 120 pages of tabulated statements of construction costs, etc. Volume II. comprises 69 maps and diagrams, devoted to comparisons of transportation facilities in different cities, traffic, plans, time-distance, charts, etc. A Merrit Taylor, transit commissioner.

CATALOGUES RECEIVED.

Portable-Mine Hoist.—An 8-page bulletin of the Chicago Pneumatic Tool Company, descriptive of this type of air hoist.

Indoor Cable Terminals.—Bulletin issued by Standard Underground Cable Co., Hamilton, Ont. 32 pages, illustrated, including dimension charts, etc.

Single-Phase Induction Motors.—A description of type K.S., manufactured by the Canadian General Electric Co. Fully illustrated. Bulletin A-4185.

Arm Improvements.—A 16-page pamphlet published by the Canada Cement Co., and devoted to the use of cement and concrete for rural roads and buildings.

Electric Fans.—A descriptive catalogue of the 1914 types of fans offered by the Canadian Westinghouse Co., illustrated with photographs, dimension diagrams, etc.

Plymouth Products.—A 12-page bulletin issued by the Plymouth Cordage Co., Welland, Ont., descriptive of Manila rope and including an article on rope deterioration.

Locomotive Ratios.—An article by F. J. Cole, Chief Consulting Engineer, American Locomotive Co., New York, issued as bulletin No. 1017, illustrated with charts and tables.

Air Compressors.—An interesting publication by the Canadian Ingersoll-Rand Co., Limited, Montreal, describing their steam and belt-driven, single and two-stage, air compressors.

Lackawanna Steel Sheet Piling.—A 48-page booklet issued as bulletin No. 106 by the Lackawanna Steel Co., illustrating numerous incidents of its use in caisson and cofferdam work.

Power and Steam Pumps.—Catalogue No. 9 of the Smart-Turner Machine Co., Hamilton, Ont., describing numerous types of reciprocating and centrifugal pumps. 32 pages, illustrated.

The Reid Incinerator.—A 16-page illustrated pamphlet descriptive of some of the Canadian installations of the Reid hot blast tube incinerator and its method of destroying garbage and refuse.

Q.E.F. Runways.—Bulletin A-12, issued by the Herbert Morris Crane and Hoist Co., Limited, of Toronto, descriptive of some interesting recent illustrations of the Morris overhead runways.

Portable Meters.—Circulation No. 1104 of the Canadian Westinghouse Co., Limited, Hamilton, Ont., descriptive of the Westinghouse types [illegible] alternating currents.

Micaspar Crystals (Formerly Granite Crystals).—A 46-page catalogue of the Crown Point Spar Company, of New York, descriptive of structures in which these crystals have been used in the coating of cement surfaces.

Heating and Ventilating a Large Factory, and **Heat Transmission Through Building Walls of Corrugated Iron.**—Reprint of articles from the Iron Age and Engineering News respectively. Issued by the Green Fuel Economizer Co., of Mattewan, N.Y.

Direct Current Generators.—Circulation No. 1156, the Canadian Westinghouse Co., Limited, Hamilton, Ont. A 28-page bulletin giving illustrated descriptions of type "R" and type "S" D. C. generators, containing also a section devoted to field rheostats.

Catenary Line Material.—Catalogue D.S. 843 of the Westinghouse Electric and Manufacturing Co., descriptive of and illustrating different types of insulators, hangers, strain cars, etc., together with spacing diagrams for wheel and pantagraph trolleys.

Water Towers.—A 24-page catalogue descriptive of steel water towers, stand pipes, etc., of the Chicago Bridge and Iron Works, Chicago, Ill. Contains many illustrations of structures in Canada and the United States. Contains also tables of frictional losses, fire stream data, etc.

Iron Ore Washing Plants.—Bulletin No. 1807 of the mining machinery department of the Canadian Allis-Chalmers, Limited, Toronto. This 16-page booklet describes several installations and contains, besides photographs, a number of plans and elevation drawings showing ore washer arrangements.

Mill Type Motors.—This bulletin, issued by the Canadian General Electric Company, describes motors for service in steel mills, etc., where they are subjected to severity of operation. Various types of mill motors are described, for instance, with open and enclosed, D.C. and A.C. Bulletin includes dimensions, etc

Standard Reinforced Spiral Pipe.—A 36-page catalogue (No. 4), dealing with reinforced spiral pipe, forged steel flanges, valves, cast fittings and specialities used in connection with them. Fully illustrated. It contains complete price lists, and gives examples and uses. Issued by Standard Spiral Pipe Works, Chicago, Ill.

Alternating Current Motors.—A 24-page booklet issued by Bruce Peebles and Co., Limited, Edinburgh, Scotland. In two sections, the first dealing with open type polyphase induction motors, and the second with another form known as the self-contained type. The catalogue contains tables of dimensions, speeds, efficiencies, etc.

Sewer Failures.—A cleverly arranged and attractively printed booklet intended to show, by camera and laboratory, the relative advantages of various materials for sewer construction. Distributed by the Clay Products Publicity Bureau of Kansas City, Mo. "Sewer Facts" is the title of another interesting booklet published for the same purpose.

Alternating Current Signals.—A 52-page booklet issued by the General Railway Signal Co., Rochester, N.Y., descriptive of alternating current block signals on Southern Railway; written by W. J. Eck, Signal Electrical Engineer, Southern Railway Co. Well illustrated with photographs, diagrams of construction, details and wiring, interlocking, etc.

Excavators.—A well-illustrated 48 pp. pamphlet descriptive of the Shearer and Mayer Dragline Cableway Excavator. Numerous photographs are presented giving a clear conception of the uses of this class of excavating machinery in the mechanical handling of material under special conditions and difficulties. Issued by Sauerman Bros., Chicago, Ill.

Electric Mine Locomotives.—32 pages, devoted to an illustrated description of the Baldwin-Westinghouse type of electric mine locomotives and their equipment. Fully illustrated to show mechanical construction and performance of this locomotive, in the manufacture of which Baldwin Locomotive Works and the Canadian Westinghouse Co. are associated.

The Industrial Harbor.—A well-bound volume of 152 pages under the title of "The Industrial Harbor," is being distributed by Deutsche Maschinenfabrik, A.G., Duisburg, Germany, whose Canadian agents are Messrs. Gerald Lomer, Limited, Montreal. The book describes practically all the lifting and transporting appliances that might be required by any harbor for handling any sort of material whatever. It is abundantly illustrated with photographs of installations that have been used [illegible] the world

Coast to Coast

Agincourt, Ont.—The huge water tank at Agincourt in course of construction by the C.P.R., was destroyed by fire on February 19. The loss is estimated at $15,000.

Berlin, Ont.—Another new industry has been opened at Berlin. The Dominion Tire Company, owned and operated by the Consolidated Rubber Company of Montreal, has completed and formally opened its new $1,000,000 plant.

Elderbank, N.S.—Work on the Halifax and Eastern Railway in the Musquodoboit Valley is progressing steadily; and it is stated that by spring the grading that is to be done by the sub-contractors will be completed, also that by July, rails will have reached the Valley.

Clinton, Ont.—Clinton is now using hydro-electric power, connection having been completed about the middle of this month. The Niagara Falls power is not only to be used for light for streets and buildings, but also for the town waterworks system. Connection with the street lighting and manufacturing plants is not yet entirely completed.

Calgary, Alta.—For the year ending December 31, 1913, the gross earnings of the Calgary Power Company amounted to $240,116.28; operating expenses, $52,055.69; leaving net earnings available for bond interest, $188,060.59. After paying interest of $100,034.33 a balance of $88,026.26 remained, equivalent to over 4¾ per cent. on the common stock.

Regina, Sask.—The new reservoir to be built at Regina, and for which a site is now being secured, will hold a reserve water supply of 5,000,000 gallons, will be 26 feet in depth, and will be constructed of concrete. The site which is likely to be recommended by the commissioners will necessitate the laying of a 42-inch main between the tank and the power house.

Fort William, Ont.—The incinerator at Fort William has been set in operation, two of the three cells being kept busy steadily. The incinerator is reported as working satisfactorily, the consumption being about one wagon load every hour for each unit, or approximately 48 loads per day. The additional air blast supplied by the new fan has made a great difference in the heat generated; and the clinker which is now raked out from the front of the furnace is hard and well burnt.

Smithers, B.C.—Extensive deposits of iron ore of great value in the Copper River district, a few miles west of Smithers, have been reported upon by Mr. John V. Rittenhouse, of New York City, consulting and mining engineer. The ore deposits are situated between the town and Copper City and are the property of the North Pacific Iron Mines, Limited. The company's locations cover 375 acres, and it is the engineer's estimate that there are 10,000,000 tons of iron ore on the property, which is brown hematite in character. The deposit is similar to the Alabama deposits of bog iron, and analysis shows it to be well within the Bessemer limit.

Brantford, Ont.—The annual report of the Dominion Power and Transmission Company gave the following facts concerning Brantford:—"At the present time the company is connected with 2,124 motors of an aggregate capacity of 55,199 h.p. Additionally, the railway capacities require 6,250 k.w., or 8,333 h.p., and our lighting systems 13,132 k.w., or 17,500 h.p. During the past year the work of reconstructing the 22 miles of street railway tracks has been continued almost to completion, and considerable work has been done in the construction of 11 additional miles for the accommodation of the rapidly increasing population in the easterly section of the city.

Montreal, Que.—According to authoritative report from Montreal, C.P.R. extension plans of last year and this year will involve a total expenditure of about $85,000,000. At the present time there are 133 miles of double track under way between Sudbury and Port Arthur, on the Lake Superior division, which alone will cost $6,000,000; 178 miles of double track between Brandon and Calgary to cost $5,000,000; 139 miles between Revelstoke and Vancouver, to cost $7,000,000. Before the C.P.R. has concluded its present programme of work in the west, including the irrigation works, double tracking, and new trackage, amounting to 1,200 miles, it will have spent approximately $450,000,000 since its inception.

Ottawa, Ont.—An interim report has been presented to the Dominion Government at Ottawa upon the construction work on the N.T.R. during the nine months ending December 31, 1913. The total expenditure during that period is shown to be $10,314,944, which brings the total expenditure from the formation of the commission in 1904 to $140,562,147. The complete mileage is given as 2,231 miles; and it is stated that at the end of last year, the bridges were 95.3 per cent. complete. The report, moreover, asserts that at the end of last year, trains were being operated on 1,160 miles of the total 1,804 miles between Moncton and Winnipeg, and could have been run on the remaining mileage had there been any necessity therefor.

Regina, Sask.—The city commissioners have adopted for this and future years the policy of laying storm sewers previous to paving. Hence, all the streets included in this year's paving programme will be provided first with storm sewers. It is proposed also to construct two new storm water mains, one of 57-inch diameter and the other, 45 inches; while in these will terminate laterals ranging from 9 to 22 inches in diameter. New later sewers will also be constructed to connect with the present main which has its outlet into the creek at Campbell Street in the northern section of the city. The proposed new sewerage mains will serve the southern portion of Regina. The estimate for the work to be carried out this year upon the above constructions—e.g., 8 miles of mains and laterals—is given by the city engineer as $170,140.

Fort William, Ont.—The laying of the new intake main across the dam at Current River has been completed. The double force main, 450 feet in length, was connected on the ice just as if it had been laid on land and then placed in a wooden frame while 14 bents were driven at equal distances across the stream to support the pulleys by which the mains were to be lowered. The ice, 3 feet in thickness, was sawed to open a channel for the main, and then the whole length was slowly lowered to the bed of the river. No supports nor flexible joints were required to prevent the pipe breaking on the bottom as the bed of the river consists of hard pan. The trench for the mains was prepared in the summer and the river bed was found so firm that blasting had to be done to remove obstructions.

Victoria, B.C.—City Engineer Rust has reported upon the recommendation, recently made by the city officials, in connection with procuring a municipal paving plant. Mr. Rust considered the advantages and disadvantages of alternative locations at Spring Ridge and Garbally road yards, estimated the cost of each, and concluded in favor of the Spring Ridge site. He reported that a quotation had been submitted from F. D. Crummer and Son for a semi-portable plant with a capacity of 2,000 yards of 2-inch top per 10 hours, for $[illegible], that this with other necessary charges,

would bring the cost of the plant to $20,000; and that the Crummer plant could be made ready for operation within four months. Before the question of location or purchase is decided, tenders are to be called and considered for necessary equipment.

Winnipeg, Man.—A preliminary report was made at the annual meeting of the Winnipeg Electric Railway Company, held recently, upon the possibilities of power development at Big Bonnet Falls. It was shown that these falls were capable of producing 150,000 h.p. of electrical energy at a very low cost per horsepower. In view of the fact that the Winnipeg Electric Railway Company's water power plant at Lac du Bonnet with a capacity of 30,000 h.p. and its auxiliary steam plants in the city of Winnipeg, with a capacity of 18,000 h.p., are being utilized to their full extent, the necessity of immediate development of the new falls was apparent and it was decided to commence exploration and preliminary work immediately. It is expected that if energetic measures are taken and the matter pushed, power can be obtained from the new site within two years.

St. John, N.B.—Mr. A. D. Swan, M.Inst.C.E., has reported to the Board of Trade upon the progress and general conditions of the harbor works being undertaken at St. John. Alterations of importance suggested by the harbor engineer are a change in the direction of the extension of the Negrotown Point breakwater to Partridge Island; a spur extension from the other side of the island as an experiment to note the effect upon currents, and as a protection to both the new wharves on the west side of the harbor, and to the entrance channel leading to Courtenay Bay; and a change in the direction of the channel to Courtenay Bay. In closing his report, Mr. Swan comments upon the detached nature of the wharf accommodation; and he suggests that some scheme be devised, such as a bridge at the head of the harbor, so that all the various railway companies have some direct access to the new wharves.

Nanaimo, B.C.—Without any cessation in operations, the entire plant of the Nanaimo Electric Light and Power Company has been replaced. During the past year, the company has installed a directly connected unit of 450 h.p., manufactured by James Howden and Company, of Glasgow. The new engine is connected to a Bruce Peebles generator of 300 k.w. capacity, in addition to which the company has put in a new 6-panel switchboard which now gives it three separate circuits throughout the city, whereas prior to this installation but one circuit was in operation. The company has also installed a Stillwell heater and a Worthington feed pump; has laid five miles of new line and erected over 100 new poles in the city. It is the intention of the company this summer to install a line throughout West and South Nanaimo. This work will be supplemented by an addition to the plant.

Halifax, N.S.—The contract which has been recently awarded to Foley Brothers, Welch, Stewart and Fauquier, for the construction of the first unit of the new harbor terminals at Halifax, calls for the erection of a pier and a landing stage, which will be unique in their solidity and massiveness. The landing stage will be of concrete and 2,000 feet in length; the pier will be 1,200 feet in length; and there will be a basin 300 feet wide built inside of an extensive filling in from the land. This will give a lineal distance for shipping purposes of 6,200 feet. The work is to be solid throughout, not a structure resting on piles. The pier foundations will consist of 2,500 celular blocks, 20 feet by 30 feet, and each weighing 60 tons. These will be laid one on top of the other. Then the celular apertures will be filled with cement and rubble, allowing for expansion and uniting one block on top of another, and steel rails also serving to reinforce the structure. The floor will be laid in concrete; and the front of the entire 6,200 feet will be faced with granite blocks from low water to the floor of the pier and landing stage.

Toronto, Ont.—The official statement issued upon road construction under the Colonization Road Department during 1913, shows a distance covered of 1,300 miles, and an expenditure entailed of $406,351. Of the three road districts of the province, the northern district received 292 miles of colonization roads and 205 miles of by-law roads. In the western district, 110 miles of colonization roads and 80 by-law roads were built; while in the rest of the province (excepting Timiskaming, which constitutes a separate district), 292 miles of colonization roads and 344 miles of by-law roads were constructed. In the Timiskaming district, the work of the Colonization Road Branch was confined to the region south of Englehart, the northern part being under the supervision of the special roads commissioner, Mr. J. F. Whitson. In the part of Timiskaming covered, 85 miles of colonization roads and 113 miles of by-law roads were constructed. Finally, extensive work was carried out upon trunk roads, the Sudbury-Sault Ste. Marie road being almost completed. It is expected that this road will be ready for traffic this summer.

Victoria, B.C.—The plans for a retaining wall along the harbor front of the old Songhees Reserve, as prepared by Engineer Valiquette of the Department of Public Works for the Dominion Government, have been approved. It is estimated that the work will cost $147,773. A considerable quantity of rock and earth will have to be excavated outside of what will be the face of the wall. An immediate start on the erection of a creosoted pile wharf and the gradings of the actual site on the Songhees Reserve to the north of the proposed Johnson Street bridge will be made as soon as the contract is awarded for which tenders are being called by the Dominion Government. The plans show a wharf fronting on the channel 420 feet in length and running shorewards 224 feet, giving an approximate total of 650 feet of piling; and which, when completed, will be 5 feet above high water level. The total area to be excavated and levelled off is about 4 acres. It is understood that by the time the preliminary contract is completed, tenders will be called for the erection of the new Marine and Fisheries depot which is to be located at the Songhees Reserve facing south on the proposed bridge.

Winnipeg, Man.—Some interesting data has recently been published, showing the excellent result of an experiment started in Winnipeg nearly 15 years ago—e.g., its civic owned paving plant. When that city decided to purchase the first asphalt paving plant from the contractors and proceed with its own work, it at first experienced much difficulty in securing a full supply of material, owing to what was known as the "asphalt trust." However, in 1910, the city secured its first portable plant with which "No. 2" pavement is laid; and to-day, about 3,000 square yards of paving can be done each day. As the system is operated, the plant is in the position of a contracting firm financed by the city. The pavement is inspected as it would be were a contracting concern laying it. While the initial cost is somewhat higher, the results have proven excellent, especially when the question of repairs is concerned, this work being done more rapidly and the disputes relative to guarantee being eliminated. The average cost to the city per yard, on business streets, has been about $2.65; but on the business streets a pavement consists first of 3 inches of gravel ballast, then 6 inches of concrete base, 1½ inches of binder course and 3 inches of asphalt wearing surface. Broken stone drains every 50 feet are also included in the cost. The city advertises every job as open to competition, the engineer putting in a bid; but the strictness of the specifications are such that contractors claim they cannot compete with the city.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page 94 a directory of such societies and their chief officials.

ONTARIO LAND SURVEYORS' ASSOCIATION.

Annual Meeting Held in Toronto, February 17th, 18th and 19th, 1914.

The morning session on the 17th was devoted to meetings of standing and special committees and meeting of the council of management.

In the afternoon, the president, Mr. J. S. Dobie, delivered his address, which was a resumé of the past year's history on matters of interest to the association. It contained many useful suggestions for the future, all of which were heartily endorsed by the meeting.

Reports of council of management, board of examiners, secretary-treasurer, committees on legislation and on publication, were presented and dealt with.

Mr. H. T. Routly of Toronto, presented his paper on "Contour Survey on Abitibi River," which evoked considerable interest. The contents of the paper were made clear and described by means of a large copy of the plan of survey.

Mr. H. O. Dempster of Gananoque, Ont., gave an interesting description of survey work in British Columbia, the different systems of survey and the conditions under which these are made.

Mr. E. W. Neelands of New Liskeard, Ont., had a paper on water power development and the transmission of electric power in Northern Ontario.

8 p.m.—Professor L. B. Stewart, of the Faculty of Applied Science, Toronto University, presented a very interesting paper on the Inter-provincial Boundary between Ontario and Manitoba, describing the different astronomical problems and the calculations involved in the question, as well as the method of procedure in defining the line on the ground.

Mr. J. F. Whitson, entertained the convention for some time with lantern slide pictures of the work of road building and colonization in Northern Ontario, and also many pictures of natural scenery in the northern and western parts of Ontario.

Wednesday Session.—Mr. C. J. Murphy, Toronto, chairman of the committee on land surveying, presented his report including answers to the question drawer, which involved the solution of many intricate points regarding the legal method of procedure in certain surveys.

Mr. T. B. Speight, Toronto, read a paper on "Surveys in Certain Townships in the 640 acre Sectional System," and some of the difficulties to be worked out where the original survey was lacking in accuracy.

Mr. A. G. Ardagh, Barrie, read a paper on difficulties arising from surveys made in double front concession townships, and pointed out several cases where the procedure under the Survey Act was not definite.

In the afternoon, Mr. G. A. McCubbin, St. Thomas, chairman of committee on drainage, presented the report which outlined improvements necessary for the good of the public and the benefit of drainage engineers.

Mr. Alan M. Jackson, Brantford, read a paper on "Permanent Street Grades," which was heartily endorsed. He advocated the fixing of permanent levels in new subdivisions in order that a builder might rely on having a fixed level of street before constructing buildings on the adjoining lots.

Mr. E. D. Bolton of Listowel, presented a valuable paper on the "Working of the Ditches and Watercourse Act," describing the difficulties arising in proceeding and carrying out drainage under this Statute.

Banquet.—The annual dinner of the asociation was held on Wednesday evening, at the Engineer's Club, and was one of the most successful dinners in the history of the association. The guests included Hon. W. H. Hearst, E. Douglas Armour, Frank Arnoldi, R. F. Stupart, F. C. Mechin, J. S. Bach, E. J. Zavitz.

Responses to the different toasts were both eloquent and humorous, and the evening was enlivened with songs by Messrs. Boyd, Phillips, LeMay, Leigh and Bartram.

On Thursday morning the association concluded its meeting by pasing resolutions, vote of thanks to all those who helped to make the convention a success. Matters of new business and unfinished business were attended to and the election of officers. The following were elected:—

President, J. W. Fitzgerald, Peterborough; vice-president, E. T. Wilkie, Toronto; secretary-treasurer, L. V. Rorke (re-elected), Toronto; council of management (2 to be elected by letter ballot), J. M. Watson, Orillia; E. D. Bolton, Listowel; Jno. H. Shaw, North Bay; G. B. Kirkpatrick, Toronto; J. J. McKay, Hamilton; auditors, Jno. VanNostramd, Toronto; A. E. Jupp, Toronto.

The meeting of the association is held on the second Tuesday in February each year in Toronto.

TORONTO BRANCH, CAN. SOC. C.E.

Toronto branch of the Canadian Society held a very important and well-attended meeting, Wednesday, February 25th, in the Chemistry and Mining Building, University of Toronto. Mr. C. N. Monsarrat, C.E., chairman and Chief Engineer of the Quebec Bridge Commission was the speaker. He gave an illustrated address on the foundation work in connection with the construction of the new Quebec bridge. The paper was most interesting, and brought forth some very complimentary discussion.

The following meetings for the Toronto branch are announced:—

Thursday, March 5th—Discussion on the "New Specifications for Reinforced Concrete."

Thursday, March 12th—Luncheon.

Thursday, March 26th—Address on "The Proposed Terminal of the T. and N.O. Railway System on James Bay," by J. G. G. Kerry, C.E.

Thursday, April 16th—Luncheon.

Thursday, April 23rd—Paper on "The Clays and Clay Industries of Canada," by J. Keele, B.A.Sc., of the Geological Survey of Canada.

The luncheons will be held at 1 p.m., and the evening meetings at 8 p.m.

Members will be notified by mail as to the place of meeting.

VANCOUVER BRANCH, CAN. SOC. C.E.

At the meeting of the Vancouver branch of the Canadian Society of Civil Engineers on February 18th, there was a discussion of the proposed Second Narrows dam and the Pitt River Canal. The discussion brought out a variety of opinions, as to the desirability, cost and effects of the proposed works.

Mr. J. H. Kilmer, engineer of Coquitlam, opened the discussion, being familiar with both the projects and having at different times studied plans and specifications for the dam as well as much data dealing with the canal, having himself made one report on the latter. The canal, he said, was an historic enterprise, having first been broached by Col. Moody, over 40 years ago. The scheme was again resurrected some 20 years ago by Mr. David Oppenheimer and associates, a company was organized for the undertaking and full surveys made with complete details of construction. These unfortunately had been lost but sufficient data remained on which to base conclusions.

The canal could be constructed either with locks at either end or with the placing of a dam at the Second Narrows which would obviate the necessity of a lock at Port Moody. The completion of either or both would make available large areas suitable for industrial sites with rail and water shipping facilities.

Others took part in the discussion including Messrs. Cartwright, Cameron, Webster, Creer and Matheson. In references to the canal, excessive cost in relation to the benefits were spoken of, and also the danger of it filling up from silt from the Fraser. Cost, too, was a feature in the dam construction with added difficulty from the depth of water over a hundred feet in mid channel, and the debris swept down by the mountain torrent which the Seymour Creek becomes at times.

Its effect on the lower inlet was also regarded as an important feature. Opinion differed as to the effect the dam would have on the tides, but the preponderance of ideas seemed to favor the theory that the dam would lessen the scour of the outgoing tide through the First Narrows and consequently increase impediments to the channel there.

PAPER ON SUBSTRUCTURES.

On Thursday evening, 19th inst., John W. Doty, A.M.Can.Soc.C.E., M.Am.Soc.C.E., of the Foundation Company, New York, read a paper at a meeting of the general section in Montreal of the Canadian Society of Civil Engineers. The subject was "Building Structures, Built by the Pneumatic Method."

ENGINEERING SOCIETY—UNIVERSITY OF MANITOBA.

At its regular meeting on the 9th inst., papers were read by Messrs. J. R. McColl and F. V. Woodman, members of the society. The latter spoke on "Elevator Construction at Fort William" and the former on "Construction of the Canadian Pacific Railway Red River Bridge." Both speakers are members of the second year in engineering, University of Manitoba.

ORGANIZATION IN ROAD BUILDING.

The Sanitary and Highway Club of the University of Toronto, a club of fourth year men in these two courses in the Faculty of Applied Science and Engineering, were addressed at their semi-monthly meeting on the 21st inst., by W. A. McLean, C.E., Provincial Roadway Engineer and a member of the Ontario Public Roads and Highways Commission. Mr. McLean spoke on the essentials of organization in road building, outlining the duties of the various members of a road staff. Some time was taken up in discussion after the lecture. Mr. J. A. P. Marshall is president of the club.

THE DEFINITION OF "CIVIL ENGINEER."

A deputation representing the civil engineers of British Columbia waited on the provincial executive council a few weeks ago with a protest against that clause in the Municipal Act which practically gives the municipalities of the province the right of interpretation of the term "civil engineer."

They suggested that the definition of civil engineer should be one who is a member of the Canadian Society of Civil Engineers or of the sister organization in Great Britain, or some society for which the qualifications for admission to membership were recognized by these two parent societies. The Premier promised that the matter would receive the consideration of the executive council.

COMING MEETINGS.

CANADIAN MINING INSTITUTE.—Sixteenth Annual Meeting to be held at Windsor Hotel, Montreal, March 4th, 5th and 6th, 1914. Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

PERSONAL.

H. G. HUNTER, resident engineer for Canada of the New York Continental Jewel Filtration Co., has been elected to full membership in the Canadian Society of Civil Engineers.

ANGUS McDONNELL, who has recently gone into large contracting work on the Pacific Coast has, according to announcements, secured from the Dominion Government the contract for the harbor works at Victoria, B.C.

J. C. DUFRESNE, M.Can.Soc.C.E., M.Can. Mining Institute, at present field engineer for Cummins and Agnew, Vernon, B.C., has resigned from the latter firm and is re-establishing his private practice at Penticton, B.C.

P. B. YATES. of Toronto, has been appointed engineer and manager of the Hydro-Electric Power System of St. Catharines, duties to commence on March 15th. Mr. Yates has been connected with the Hydro-Electric Power Commission of Ontario for the past five years, previous to which he was in the employ of the Gould Storage Battery, Chicago.

ARTHUR H. BLANCHARD, M.Am.Soc.C.E., Professor in Charge of the Graduate Course in Highway Engineering at Columbia University, on February 14, 1914, delivered illustrated lectures at the University of West Virginia on the subjects:—"Park Boulevards," "Bituminous Surfaces and Bituminous Pavements," "Wood Block and Stone Block Pavements" and "Modern Developments in Highway Engineering in Europe."

GEO. D. MACKIE, formerly city engineer of Swift Current, Sask., has secured the long-deferred appointment of City Engineer of Moose Jaw, Sask. Some 40 applications were received last fall and the work of selection has been slowly, but carefully, proceeded with. Mr. Mackie has had some 13 years' experience in municipal work. He was with the John Galt Engineering Co., at Winnipeg and Calgary before taking office at Swift Current. A greater part of his municipal training [illegible] in [illegible] and Clydebank

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21351—February 12—Extending, until the 15th day of May, 1914, the time within which to complete the spur for the Renfrew White Granite Co., Limited, township of Ross, Ont.

21352—February 9—Ordering the C.P.R. to appoint a permanent agent at Millett Station, Alta.

21353—February 12—Extending, until the 21st May, 1914, the time within which to construct switching lead in the city of Toronto, Ont.

21354—February 12—Approving revision in the location of a portion of the C.P.R. Co.'s Columbia and Western Line at mileage 0.45, Granby Subdivision, through Lot No. 1494, Group 1, and Lot No. 332, Group 1 (Provincial Government Survey, District of Yale, B.C.).

21355—February 12—Authorizing the G.T.P. to carry traffic on the said portion of its main line of railway east of Prince Rupert, B.C., between mileage 301 and mileage 337.

21356—February 12—Approving, temporarily, G.T.P. Standard Freight Mileage Tariff, C.R.C. No. 21, incorporating and superseding C.R.C. No. 19, by an extension of the mileage thereof, to apply between stations in the Province of British Columbia, between Prince Rupert and Wordsworth, inclusive.

21357—February 9—Granting leave to the Hydro-Electric Power Commission of Ontario to erect, place and maintain its line across the wires and across the track of the C.P.R. on Main St., Chesterville, Ont.

21358—February 13—Approving Plan "A," showing G.T.R. bridge No. 63, mileage 152.51 from Black Rock, over public road at Golmesville, Twp. Goderich, Ont.

21359—February 14—Authorizing G.T.R. to reconstruct bridge No. 52, at mileage 127.75 from Black Rock, on the 20th District of its line of railway, Twp. Fullarton, Ont.

21360—February 13—Authorizing the C.P.R. to construct a highway diversion in the S.E. ¼ of Sec. 26, Twp. 3, Rge 29, W. 3 M., Sask.; and to construct, by means of a grade crossing, the tracks of its Weyburn-Stirling Branch Line across the highway between Secs. 25 and 26, Twp. 3, Rge. 29, W. 3 M.

21361—February 14—Authorizing the C.P.R. to construct highway diversion in Sec. 1, Twp. 23, Rge. 2, W. 4 M., Alta.; and to construct, by means of a grade crossing, the tracks of its Bassano Easterly Branch Line across said diversion at mileage 111.3.

21362—February 14—Authorizing C.P.R. to construct highway diversion in Sec. 9, Twp. 23, Rge. 1, W. 4 M., Alta.; and to construct, by means of a grade crossing, the tracks of its Bassano Easterly Branch Line across said Diversion at mileage 114.7 on said Branch line.

21363—February 13—Authorizing C.N.Q. Ry. to construct, maintain and operate siding into sand pit at mileage 16.90, west of Joliette, for E. Dupuis, St. Julienne, Co. Montcalm, Que.; and to cross with such siding the said public road to Bissonnette, at Station 66.70.

21364—February 13—Authorizing the C.P.R. to construct, at grade, the tracks of its Swift Current Northwesterly Branch Line, at mileage 169.89, across the tracks of the C.N.R. Co.'s Goose Lake Branch at Mileage 210.12, in Sec. 29, Twp. 28, Rge. 5, W. 4 M., upon certain conditions.

21365—February 13—Authorizing the Township of McKim to construct and maintain a highway crossing over the Algoma Eastern Ry. in Lot 11, Con. 4, Twp. of McKim.

21366—February 14—Authorizing the C.P.R. to construct, maintain and operate branch line of railway, or siding, for the Conger Lehigh Coal Co., Limited, Toronto, Ont., on subdivision Lots 12, 13, 14, 15, 16, 17, 18, 19 and 20, lying northerly of Vine St., Toronto, Ont.

21367—February 17—Amending Order No. 21172, dated January 7th, 1914, by striking out word "Broadview" in third last line of recital to said Order, and substituting word "Brandon."

21368—February 17—Authorizing Kettle Valley Ry. to carry traffic over portion of railway from Penticton Wharf, in westerly direction, a distance of 17 miles, B.C. And that portion extending northerly and northwesterly from Carmi to mileage 76.5, Prov. B.C., a distance of 30 miles.

21369—February 16—Rescinding Order of Railway Committee of Privy Council of Canada, dated Sept. 1st, 1899.

21370—February 17—Authorizing C.P.R. to construct spur for Henry Hope & Sons, of Canada, Ltd., in Park Lot 4, Tp. Lot No. 13, Con. 12, formerly Tp. of Monaghan, now City of Peterborough, Ont., subject to certain conditions, and rescinding Order No. 21232, dated Jan. 19th, 1914.

21371—February 17—Directing that C.N.R. reconstruct its station building at Aberdeen, Sask., work to be completed by first day of July, 1914.

21372—February 17—Authorizing C.P.R. to construct road diversion in Sec. 26-21-5, W. 4 M., Alta., at mileage 88.9 of Bassano Easterly Branch Line.

21373—February 17—Authorizing C.P.R. to construct diversions of East and West road allowance in Sec. 2-22, and Sec. 34-21-7, W. 4 M., Alta.; and construct, by grade crossing, Bassano Easterly Branch Line across North and South road allowance between Secs. 2 and 3, Tp. 22 and Secs. 34 and 35, Tp. 21, Rge. 7, W. 4 M.

21374—February 17—Authorizing C.P.R. to construct highway diversion, as revised, in Sec. 20-21-8, W. 4 M., Alta., and to construct Bassano Easterly Branch, by means of grade crossing, across said diversion at mileage 66.39.

21375—February 17—Granting leave to C.P.R. to carry party of mining students of McGill University at special rate of $40.00 per capita for trip from Montreal, Que., to Rossland, Phœnix, and Greenwood, B.C., and return, or at $50.00 per capita from Montreal to Vancouver, B.C., and return, including side trips to Rossland, Phœnix and Greenwood, B.C. 2. Granting leave to carry such party, if desired, over lines from Sudbury to Sault Ste. Marie and back at rate of $2.75. And that any other parties desiring to travel for same purpose to British Columbia or any other mining district, be granted equally favorable terms, until otherwise ordered by Board.

21376—February 19—Authorizing C.P.R. to construct Bridge No. 62.8 over Magnetawan River, near Byng Inlet, Ontario.

21377—February 18—Authorizing C.P.R. to use and operate Bridges Nos. 25.7, Laggan Sub. Div., Alta.; 92.3, Boundary Sub. Div., B.C., Div., B.C., and 176.9, Calgary Sub. Div., Alberta Div., Alberta.

21378—February 18—Making Montreal Warehousing Co. a party to application of Montreal Board of Trade for an Order directing G.T.R. to put into effect at its Montreal Elevator the same charges and conditions for elevation, storage, and loading of grain into cars as are in force at its elevators at Georgian Bay ports.

21379—February 19—Authorizing G.T.P. Branch Lines Co. to construct road diversion in S.W. ¼ Sec. 24-1-3, W. 2 M., Sask., at mileage 151.5 on Regina-Boundary Branch.

21380—February 19—Amending Order No. 21161, dated Jan. 7th, 1914, by striking out words, "and G.T.R. Co., as set out in letter of McCarthy, Osler, Hoskin & Harcourt to Chrysler & Bethune, dated Jan. 6th, 1913," in 3rd, 4th, 5th lines of recital to Order, and by adding at end of said recital words, "and the G.T.R. Co. of Canada, under a reservation of its rights, if any, as a riparian proprietor, not objecting."

21381—February 19—Amending Order No. 21139, dated December 31st, 1913, by striking out word "Saskatchewan," where it occurs in said Order, and substituting word "Alberta."

21382—December 12—Authorizing C.N.R. to construct across nine (9) highways on its Alsask Southeasterly Line in Saskatchewan.

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HIGHWAYS AND HIGHWAY SURVEYING

FURTHER POINTS ESSENTIAL TO A SCIENTIFIC APPLICATION OF SURVEYING PRACTICE TO HIGHWAY WORK—SUGGESTIONS PERTAINING TO LEVELLING

By **DANIEL J. HAUER**
Consulting Engineer and Construction Economist

[*Note—This article on levelling in connection with highway surveying follows directly the subject matter of another which appeared in February 19th issue under a similar heading. The plotting and some other features of highway surveying will be dealt with in a later article.—Editor.*]

The Work of Levelling.—The taking of levels over the surveyed area is of great importance and should be done with care and judgment. If possible, a bench mark established above tide water should be obtained to start the levels. This can frequently be done from some railroad company or government survey. If this is not possible, and the surveys start near tidewater, a gauge should be put on the beach, and mean tide or mean low water obtained. The value of this is evident. On extensive surveys all sections of the work can be checked if the levels are on the same datum line. These levels can also be used for any work, and it is always of value to have them based on tide water. However, if it is not possible to get such an elevation to start the levels, an assumed elevation can be used, taking care that it is large enough to prevent any minus elevations.

With a bench mark to start from, the first work to do is to run a set of benches over a part of the surveyed line. This is one difference between highway surveying and railroad surveys. On highways the line of the survey is known, while on railroads it is not. Thus benches can be run ahead of the transit party. With a set of benches run, they can be checked as the line levels are taken, thus the levels are checked as they are taken. It is customary to run the levels as the benches are established, afterwards checking the benches. By this method, if errors are discovered, either a long line of levels must be run over or else two elevations from a bench mark must be used, one in each direction from the error, which is a great inconvenience and may lead to other mistakes.

If the benches are run first and then checked the levels can be kept right, it seldom being necessary to run over more than 1,000 ft. By all means, no matter how they are run, have the levels and bench marks checked. This is the only proper method and will save much confusion later, as well as time and money.

Levels should check within a few hundredths between benches and within a tenth for a mile. If they do not, they should be re-run until they do. Bench marks should be established about every 500 ft., making about 10 per mile. In very level country they can be farther apart, but even then not more than 1,000 ft. It is very little trouble to make benches, and to have them close together means the saving of much work on locations and construction. They should always be established near cross roads and bridges. If the bridge is high there should be one at the road level and one near the stream, so that work can be done from one set up on any part of the structure. If the bridge is a long one, a bench should be on each side, and these should be checked within one hundredth of a foot.

Bench marks can be made on the knots of trees. These are most permanent and can be used for some years. Door steps and curb stones in towns and villages can likewise be used. When trees or stones are not convenient, heavy spikes can be driven into telephone or telegraph poles along the road. Any heavy spike will do if it is driven securely, leaving only enough of the head projecting to the bear level rod. A railroad spike gives the best bench mark of this kind.

Many poles have to be removed to allow of road improvements, so it is often necessary to transfer bench marks from one pole to another. Other expeditious ways of making bench marks will suggest themselves. If the work is extensive enough and the cost will warrant it, permanent stone or concrete monuments can be set for some of the bench marks. These should have a copper tack or plate set in them, and if of concrete the elevation should be cast in the concrete.

If possible, all bench marks should have their elevations marked on them. A description of each should be entered in the note book with its location described in reference to the transit line. A list of bench marks, their elevations and description should be entered in the back of each level note book for quick reference.

In taking levels, each station should be taken on the transit line and at each break in the ground. When the transit line is not the same as the centre line of the road the centre must also be taken. These two elevations are most important. In addition to them the elevation on the sides of the roads should be taken. If the ground dips or rises much beyond the sides of the roads, enough elevations should be taken to show the character of the ground to about the limit of the right-of-way of the road. From such notes it is possible to plot cross-sections of the road.

It is evident that with the large number of levels to be taken and with checking the bench marks, the work of levelling on highway surveys goes much slower than the work of running the transit line. Thus every help

possible should be rendered the leveller and his rodman. Plus stations marked on poles, fences, stakes, culverts and bridges will all aid in making measurements. If the road does not vary much in elevation from one side to the other and if the ground on the sides is about the same, it is evident that quicker progress can be made by only taking side levels every 200 instead of 100 ft. Other opportunities of saving time will present themselves to the leveller. The successful levelman is he who is so watchful that he does not waste time by taking useless notes and at the same time makes his notes so complete that a profile can be made of the transit line, of the centre line and of each side of the wagon road; and any cross-section that will show decided cutting and filling in widening the road.

work, both in recording the notes and in plotting them. This is to place all the rod readings in one column and the elevations in another, and on the opposite page show by notations the places where these levels were taken. This is shown by a sample page, Fig. 1.

The second method is similar to keeping cross-section notes. The rod reading for the transit line and its corresponding elevation is recorded, as usual, in the columns on the left-hand page and the rest of the readings on the right-hand page, as shown in Fig. 2. It is possible to set down the elevation directly instead of the rod readings, by doing some extra work in the field. Thus, above the break shown on the page, the top figures are rod readings and the bottom figures distances out from the transit line. The letter "C" denotes the centre

1 Sta.	BS	H of I	F.S	Rod	Elev.	2
B.M.					62314	On Root of Spruce Tree 50' left of Sta. 0
	5142	67456				
0				6.2	61.3	Transit Line
0				6.2	61.3	2' right C. Road
0				6.4	61.1	8' right Side Road
0				4.1	63.4	12' " Bank
0				6.5	61.0	8' left side Road
1				5.8	61.7	Transit Line
1				5.7	61.8	3' right C. Road
1				5.5	62.0	9' right Side Road
1				5.3	62.2	11' right Bank.
1				5.4	62.1	7' left
1+50				4.8	62.7	Transit Line
1+50				4.8	62.7	C. Road 3' right
2				3.2	64.3	Transit Line
2				3.1	64.4	4' Right C. Road
2				3.0	64.5	10' right Side Road
2				2.9	64.6	6' left side Road
3				1.2	66.3	Transit Line
3				1.2	66.3	5' right C. Road
T.P.			0.912		66.544	on rock near Sta. 3
	10.865	77.409				
4				9.8	68.6	Transit Line
4				9.7	68.7	5' right C. Road
4				9.6	68.8	12' " side Road
4				9.5	68.9	4' left " "

Fig. 1.—Ordinary Level Book, With Notes.

At cross roads levels should be run down the centre of the roads for such distances as to show the grade of these roads and how they may be affected by changes to be made. This may mean 100 ft. or more. On private roads and entrances to farm houses, levels should be taken for at least 100 ft. or to the houses. At culverts and bridges, in addition to levels taken in the road, the elevation of the banks of the stream, the surface and bottom of the water should be ascertained, and any other elevations that may affect the building of a new bridge or culvert.

The Levellers' Note Book.—The keeping of level notes is not a difficult problem, but unfortunately the manufacturers of note books have not kept abreast of the times, there being no special book for highway surveys. The one in common use is well adapted to railroads, but is poorly suited to highways as it causes much extra

of the wagon road. The figures written vertically are the elevations of the points alongside of them.

Below the break in the page (Fig. 2) the top figures are the elevations and the bottom figures, distances out. In this the rod reading is not recorded except for the reading on the transit line. Thus, at Station O (zero) the rod reading is 6.2 on the transit line, the instrument height being 67.5; the elevation as recorded is 61.3. Now, keeping the rod 6.2 on a piece of paper, as the mean rod for that cross-section, the reading at the centre of the road, being 6.2, gives an elevation of 61.3, which is set down on the right-hand page as 2 ft. on the right and at centre. The reading at the edge of the road, 8 ft. out, is 6.4, being 2 tenths lower than the transit, making an elevation of 61.1, which is so recorded. At 12 ft. out the rod reads on top of the side of the cut 4.1, making a difference of 2.1 with the mean rod, thus adding 2.1 to

the elevation on the transit line, making 63.4. The same is done on the left, and at each station the operation is repeated. The notes are thus made complete in the field and a large number of levels can be taken and recorded on a section. Although some time is saved in the long run, yet in cold weather it is difficult to do this in the field, and the chance of errors being made is considerable.

Fig. 3 shows a method of keeping level notes that is less work than that shown in Fig. 1, is very accurate, and can be used by a leveller of limited experience. A cross-section book for plotting contours can be used and ruled up in any manner desired. For standard use the writer uses the ruling shown in Fig. 3. The columns for rod readings are made narrower than for elevations for two reasons, as so much space is not needed, and the recorder can find them more easily. The figures in circles with the rod reading tell the distance out to the right or left of the transit line. With this method the notations necessary in Fig. 1 are eliminated by the columns and the elevations except for the turning points, bench marks, and instrument heights, can be marked up in the office. The writer is a firm believer in keeping the elevations mentioned marked up in the field, and checking them each night by addition and subtraction.

It is evident that plotting the notes shown in Fig. 3 any line or profile can be plotted with little trouble. The elevations of the transit line, the centre line of the road, the sides, etc, are all in single columns, except where the transit line coincides with the centre of the road only the elevation of the transit line is shown.

Each night, or on stormy days, all elevations should be marked up and the notes plotted.

1 Sta.	B.S.	H. of I.	F.S.	Rod	Elev.	Left	Right 2
B.M.					62.314	on Root of Spruce Tree	50' left of Sta. 0
	5.142	67.456					
0				6.2	61.3	6.5/8.0	c6.2/2.0 6.4/8.0 4.1/12.0
1				5.8	61.7	5.4/7.0	c5.7/3.0 5.5/9.0 5.3/11.0
1+50				4.8	62.7		c4.8/3.0
2				3.2	64.3		c3.1/4.0 3.0/10.0
3				1.2	66.3		c1.2/5.0
T.P.			0.912		66.544	on Rock	
B.M.					62.314	on Root of Spruce Tree	50' left of Sta. 0
	5.142	67.456					
0				6.2	61.3	61.0/8.0	c61.3/2.0 61.1/8.0 63.4/12.0
1				5.8	61.7	62.1/7.0	c61.8/3.0 62.0/9.0 62.2/11.0
1+50				4.8	62.7		c62.7/3.0
2				3.2	64.3	64.6/6.0	c64.4/4.0 64.5/10.0
3				1.2	66.3		c66.3/5.0
T.P.			0.912		66.544		

Fig. 2.—Two Different Methods of Keeping Level Notes.

1 Sta.	B.S.	H. of I	FS	Elev. Benches etc.	Transit Line Rod	Transit Line Elev	Left Rod	Left Elev.	Left Rod	Left Elev	Centre Road Rod	Centre Road Elev	Right Rod	Right Elev.	Right Rod	Right Elev
B.M.				62.314	(Spruce Tree	50' L. Sta 0)										
	5.142	67.456														
0					6.2	61.3			6.5 (8)	61.0	6.2 (2)	61.3	6.4 (8)	61.1	4.1 (12)	63.4
1					5.8	61.7			5.4 (7)	62.1	5.7 (3)	61.8	5.5 (9)	62.0	5.3 (11)	62.2
1+50					4.8	62.7					4.8 (3)	62.7				
2					3.2	64.3			2.9 (6)	64.4	3.1 (4)	64.4	3.0 (10)	64.5		
3					1.2	66.3					1.2 (5)	66.3				
T.P.			0.912	66.544	(on Rock)											
	10.865	77.409														
4					9.8	68.6			9.5 (4)	68.9	9.7 (6)	68.7	9.6 (12)	68.8		

Fig. 3.—Showing Note Book With Level Notes.

COMMERCIAL RED LEAD FOR PAINTING STRUCTURAL STEEL.

By A. Gordon Spencer,

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RED lead is one of the best-known and most widely used pigments at the present time for painting steel for structural and railway purposes, but very few of the consumers seem to realize the great difference in quality of the red leads sold by the manufacturers and jobbers, nor the effect of the ingredients upon the quality and durability of the paint in service.

Red lead as sold on the market is mainly a mixture of two oxides of lead, true red lead and litharge. It is made by roasting, or oxidizing, pure metallic lead in reverberatory furnaces in two stages. In the first stage the lead is melted down on the flat hearth of the reverberatory while a strong current of air is passing across its surface. Litharge, or the monoxide of lead, is formed under these conditions as a skin or crust upon the surface of the molten metal and is pushed to the back of the furnace, continually exposing fresh metallic lead to the oxidizing action of the air. Finally, all the lead becomes changed into brown-colored scales of litharge, which on grinding produce the reddish-yellow litharge of commerce. The second stage in the process consists in the further oxidation of the ground litharge in the same or a similar reverberatory furnace to true red lead. The temperature and other conditions have to be carefully controlled or, otherwise, the bright red color will be spoiled and the quality of the pigment impaired. If the oxidation is not carried far enough considerable litharge will still remain and the color will be pale. If carried too far the red lead becomes more dense and crystalline, and hence is more difficult to mix with oil into a paint and is liable to run or streak. If the temperature becomes too high, the red lead is decomposed to litharge again and a partial fusion of the material will result. The final product should contain no grains of metallic lead nor fused particles, but after grinding very fine should be of a brilliant red color and with only a small quantity of litharge.

The chemical composition of true red lead is considered to be a compound of two parts of lead monoxide and one part of lead dioxide, but the commercial product always contains litharge in varying proportions as the analyses given in Table I. will show.

Red lead containing a large percentage of litharge when mixed with oil sets into a cement in a comparatively short time. This makes it difficult to work and uneven in application. A pure red lead, on the other hand, is more inactive to oil and brushes out more smoothly. This allows the painter to cover more surface with the same quantity of paint with less exertion and in a shorter time, so that the increased cost of a high-grade red lead is more than repaid by the economy in application, as well as in the increased beauty and durability of the paint; not to mention the better protection of the steel work obtained. Fineness of grinding is, of course, an essential characteristic, as otherwise even a high-grade red lead would run and alligator.

In view of the wide variation in the purity and quality of the commercial article now on the market it would, therefore, seem advisable where large contracts are concerned and where durability and uniformity of the painting is necessary, to buy it under specifications and to rigidly inspect and test all shipments received. The following might be suggested as a specification for this purpose:—

Specification for Dry Red Lead.—The dry pigment must be of the best quality, free from all adulterants, and shall contain not less than 85 per cent. by weight of true red lead (Pb_3O_4), the balance to be practically pure lead monoxide (PbO). It must contain less than 0.1 per cent. of metallic lead, and is to be of such fineness that not more than 0.75 per cent. remains after washing with water through a No. 19 silk bolting-cloth sieve. It must be of good, bright color, and be equal to the standard sample in freedom from vitrified particles and in other respects.

Samples of one ounce of the dry red lead must be submitted to the..............Company's Chemist for analysis for each new order for the materials. No material shall be shipped until the above sample has been approved by the Chemist. Shipments must be uniformly in accordance with the specification. Further samples may be taken at any time after delivery, and if the material is found not to be in accordance with the specifications, all the materials represented by such samples shall be rejected.

Standard samples of dry red lead will be furnished on application to the..............Company's Chemist.

Wherever possible it should be arranged to have the shipments of red lead sampled before shipment, so that all trouble, delay and possible disputes may be avoided by reason of the shipment being rejected after delivery had been made. The buyer, or his representative, could then get an unbiased average sample of the different barrels of material, seal them with his own private stamp, taking note at the same time of the numbers and marks of the barrels. If the analysis proved satisfactory the latter could then be checked up and identified upon delivery. In this way no further delay nor trouble should result and both buyer and seller would be equally satisfied.

Table I.—Analyses of Dry Red Leads.

Serial No.	True red lead *	Litharge.*	Oxide of iron.*	Barytes.*	Whiting.	Zinc Oxide.	Other mineral matter.	Organic coloring matter (dye).	Total lead.*	Residue on No. 19 silk bolting cloth.*	Color.
1	63.57	32.03	.36	None	None	None	None	....	....	Good	Good
2	56.00	43.39	None	....	....	....	"	None	91.04	8.17	Pale
3	94.85	5.05	"	....	....	....	"	"	90.58	1.55	Excellent
4	71.43	27.89	"	....	....	....	"	"	90.63	2.05	Good
5	77.37	21.71	"	....	....	....	"	"	90.29	3.03	Good
6	52.48	46.30	"	....	....	....	"	"	90.56	3.4	Good
7	55.35	42.94	"	....	....	....	"	"	90.01	4.4	Good
8	38.71	30.66	....	27.40	....	....	....	Present	....	....	....
9	60.45	38.61	None	....	....	....	None	None	90.63	....	Paler
10	71.88	26.91	"	....	....	....	"	"	90.15	3.8	Good
11	87.16	12.72	"	....	....	....	"	.12	90.84	2.6	Good
12	66.81	32.45	"	....	....	....	"	None	90.70	1.3	Orange
13	88.45	11.39	"	....	....	....	"	"	90.77	.81	Pale

* Percentage.

SOME FEATURES IN THE DESIGN OF SEWER SYSTEMS.

THE design of a sanitary sewer system for a town having a combined system serving approximately 2/3 of its area and 9/10 of its population and the subsequent construction of parts of the system and of some storm sewers is the subject of a paper read recently before the Association of Civil Engineers of Cornell University and appearing in the February number of The Cornell Civil Engineer. Mr. C. F. Fisher, of the Fairport (N.Y.) Sewerage System, is the author.

In the particular case which Mr. Fisher selected the existing sewers had been built without regard to any particular outfall, and the problem was that of combining them into a system which should serve the entire community and deliver the sewage at some outfall convenient for the treatment of the sewage.

Before proceeding to the actual design of a sewer system, the factors of future growth of the town, the character and quantity of its sewage, the conditions of its present sewers and the local topography must be considered. In estimating future growth not only the corporate area should be included, but the areas which are liable to be developed during the period it is assumed to care for. The railway facilities will usually indicate in what direction new industrial works may be expected to grow up, but the development of residential districts does not admit of such accurate forecasts. In the smaller cities and towns the main highways which are susceptible to improvement as state roads are the more likely avenues of development.

The character of the sewage will govern somewhat in the selection of the minimum grades to be used. Where manufacturing wastes of a fibrous or a gritty character occur it will be necessary to provide for a higher velocity of flow, preferably not less than three feet per second, than where domestic sewage only is expected. This requirement becomes more important where the discharge is periodic in sewers maintaining only a small normal flow. A dilute sewage admits of a lighter grade than a heavy one, and more especially so if its diluteness is due to the infiltration of ground water in old sewers, since that fact insures a steadier flow. In a separate system the problem of street grit can be eliminated by the use of tight manhole covers, or, if perforated covers are necessary to provide ventilation, by the use of dustpans in manholes.

In estimating the amount of sewage per capita per day to be expected recourse will be had to the records of water consumption for the community in question. These records, if pumping records, or records made at the intake of the water system, will show a consumption which will be in excess of the flow of sewage by the amount of leakage in the waterworks lines. However, other facts concerning the water supply may be large factors in the expected sewage flow. At Fairport, N.Y., the water consumption from pump records for the winter months, when sprinkling, etc., was zero, was 65 gallons per capita per day. This water is obtained from shallow wells in shale and is highly mineralized. In consequence, the use of cisterns to catch roof water is universal. No records were available showing what the actual per capita consumption of this roof water was, and in the absence of any definite data, an allowance of twenty gallons per capita per day was made, as being sufficient to cover general domestic uses. The cisterns in which this water is collected drain into the sewers, which will form a part of the sanitary sewer system, and, during heavy rains, all the overflow from the cisterns will pass through the sanitary sewers. The amount of this overflow is difficult of estimation. A computation of the amount to be expected by means of roof area and rainfall data, assuming that only 10 per cent. of the cisterns would overflow at once, gave an amount of water manifestly too large to provide for in sanitary sewers. It was not possible in this case to observe the increase in flow due to rains because a great many surface laterals were connected to the sewers and contributed to their flow. It was advisable to make some allowance for this water because of the limited extent of the storm water system and the probability that it would not be extended to cover the town for some time. The total amount of sewage proper to be expected was determined as 80 gallons per capita per day and the maximum flow on the maximum day as 170 gallons. An allowance of 100 gallons was made for cistern overflow in addition to the sewage flow. This amount seems liberal, and the sewers were not designed to carry this amount flowing half full but practically three-quarters full. In case future experience should show this amount to be too small an allowance for cistern overflow, the remedy will lie in connecting the overflow to the storm sewers, whose construction should be assured before the main trunk sanitary sewers carry the flow from the full estimated population for which they were designed.

The condition of the existing sewers is sometimes hard to determine, especially where no maps have been filed or manholes built along the line. The grade of many of them is an indeterminate thing as they have frequently laid over an uneven bottom. The fact that they are discharging sewage is presumptive evidence that they are in fair condition. However, when it is designed to lay pavements over them, it is necessary to dig up the sewer at several critical points before assuming its efficiency, and manholes should then be built along the line.

The proper layout of the system to take advantage of the local topography, can only be finally determined by making actual estimates of cost of the best of the apparent locations. The inclusion of the old sewers complicates the problem as they were frequently built in short sections at a time, following the growth of population, and do not take advantage of the steepest grades available. Theoretically, the most economical type of layout is that in which the main trunk sewers follow the steepest grades, since the smaller laterals seldom carry their full capacity, even on light grades.

Before proceeding to the layout of any comprehensive sewer system it will be economical to make a good topographic map of the area to be sewered and any probable extensions to that area. Such a map should include all probable sites for disposal plants and all areas contributing surface drainage. A scale of 100 feet to the inch shows detail enough for fairly smooth country where the slopes do not exceed 10 per cent., but in rough topography and in locations which a preliminary examination shows to be likely routes for intercepting sewers a scale of 50 feet to the inch is preferable. A contour interval of 2.5 has been found satisfactory in smooth country, and ten feet is close enough for long, steep slopes. It is advisable to write in the actual elevation at street intersections and abrupt changes of slope. The amount of detail it is advisable to show on these maps depends somewhat on the probable time of construction. If the investigation is only preliminary in character and actual construction is liable to be long deferred it is useless to take a large amount of detail, which may change materially before actual construction. But where it is expected to build shortly, it is a matter of economy to locate the houses and all structures, even if they do not actively govern the location of the sewer. From these large scale maps a map of a smaller scale, 200 or 300 feet to the inch, can be prepared as an index map, or for

filing purposes. It is helpful also, where the topography is complex, to have a small scale map to bring out the general features of the country more prominently than is possible with several separate maps. In transferring topography to the small scale map it is essential to transfer the street lines and main drainage lines and divides with a fair degree of accuracy. The absolute correctness of intermediate points is not so essential since final locations and estimates will be made from the large scale maps. These maps will be of great value in future municipal work if they are filed in the city offices so as to be available.

The method of preparation of these maps will depend largely on the tastes and previous experience of the engineer in charge of surveys. It is possible to make fairly good maps by the method of transit topography and a draftsman to plot the transitman's notes, but the cheapest and most accurate method is by plane table surveys. By this method there is so much less detail left to the draftsman's imagination. It is necessary to use the transit and level to secure adequate control for plane table surveys, and distances, such as length of streets, should be chained unless accurate maps showing such lengths are available. In open country a transit survey to locate control points not less than 1,000 feet apart should be made and level bench marks established every 1,000 feet in distance and at least every 20 feet in elevation. With the control points plotted on plane table sheets about 20" by 30" and a party consisting of topographer, recorder and rodman, maps can be made which will be superior in their general accuracy to maps made by the transit method, and will be almost as cheap.

In these maps all existing sewers should be located and their exact elevations determined, even if it is necessary to dig them up to do so. Attention needs to be given to the grades of water and gas mains parallel to the new sewers, since they may interfere with the house laterals.

Before proceeding to lay out a system on these maps it is necessary to consider whether a storm sewer must be built in the near future in streets now served by existing combined sewers, if no storm sewer is to be built the old sewer will be used if possible as a part of the new system. If a storm sewer needs to be built, the question arises whether the existing sewer is of sufficient capacity to serve as a storm sewer for the area. The fact that it has so served is not evidence that it will continue to do so under new conditions incident to prospective street improvements, etc. In this case, in order to obtain the best design, it becomes necessary to practically lay out a storm sewer system for the town. It will usually be found that the old sewers are too small to be used for storm sewers. In a case in mind in only one instance was the old sewer of sufficient capacity to provide proper drainage. Here the old sewer was used for a storm sewer and a new sanitary sewer built. Questions of the efficiency of the existing sewers as sanitary sewers also affect the design. It is possible that they are entirely too large to be self-cleansing when the drainage of the street no longer enters to periodically flush them. This fact, combined with the infiltration of ground water, may be serious enough to warrant the construction of a new sanitary sewer. Unless the street is to be immediately improved, or the use of the old sewer makes a considerable detour in the direct route of the new construction necessary, however, it will be best to use the old sewer for a sanitary sewer if its grade permits. In case it develops into an active nuisance a new sewer to take its place can always be laid later.

A further point deserving of more consideration than it usually receives, especially in small communities, is the securing of proper ventilation of the sewers. The common method in large cities is by the use of ventilating ducts through the houses to the roof. In small communities it will be found, however, that a large proportion of the houses have house-traps, which prevent the circulation of air through the sewers and ventilating ducts. In such cases it is necessary to secure the passage of an ordinance prohibiting house-traps or ventilate the sewer through perforated manhole heads. It is usually easy to secure the passage of the ordinance, but where the town does not have a plumbing inspector it is a difficult matter to enforce it. The enforcement of such an ordinance is, however, so essential to prevent nuisances from foul-smelling manholes that every effort should be made to secure competent inspection of the installation of house fixtures.

For sewers of small sizes the use of vitrified clay or tile pipe is universal. Vitrified pipe, however, is so subject to breakage, due to the unyielding character of the material and the imperfect bedding of the pipe usually secured, that more attention should be given to the prevention of breakage than is commonly done. It is a common practice to place a concrete or timber foundation under sewers where the bottom is soft. The restriction of this foundation to soft bottom indicates an intention to provide against settlement rather than against breakage. In this connection it is interesting to note a discussion of the strength of sewer pipe by Dean A. Marston and A. O. Anderson, of Iowa State College, in which they conclude from their observations that (1) it is impossible to prevent cracking of the larger sizes (over 15") of pipe by precaution as to bedding and laying the pipe or refilling the ditch; (2) that pipe cracks more readily on hard, unyielding bottom than on soft bottom; (3) that it is necessary to require the contractor to carefully shape the bottom of the ditch to conform to the surface of the under half of the pipe; (4) and to carefully bed the pipe in sand or granular material; (5) that sewer pipe cracks from such slight distortions as compared with the yielding of the most solidly packed earth filling that it is not possible to prevent cracking by side-tamping at the mid-height; and (6) that when the above precautions do not prevent failure it is necessary to bed the pipe in concrete up to its mid-height or else use stronger pipe. These conclusions are not verbatim as given in the Record, nor do they comprise all of their conclusions, but they state the gist of their conclusions as to prevention of failure by care in laying pipe.

Their statement that pipe cracks more readily on hard bottom than on soft is illuminating when regard is had to the practice of placing concrete foundations on soft foundations only. Their conclusion (3) as here enumerated is practically impossible in hard and stony soils, and is almost never done in any soil. In any soil such a requirement entails an amount and quality of inspection rarely given to pipe sewer construction. Conclusion (4) seems more possible of attainment, but would require that the trench be excavated larger and deeper than the outside of the pipe and the granular material placed and tamped around and under the pipe. Their conclusion that "sewer pipe cracks from such slight distortions as compared with the yielding of the most solidly packed earth filling that it is not possible to prevent cracking by tamping the ditch filling on each side of the pipe at mid-height," indicates the equal impossibility of preventing cracking by excavating the bottom of the ditch to a cylinder true to the line and grade of the outside of the pipe. An attempt to secure this condition will result in leaving narrow cavities under the pipe too small to be tamped full of earth, and "slight distortions" of the pipe will be very apt to occur.

It appears that the statement "that when failure occurs in spite of the careful observance of the other precautions, the only effective remedy is to bed the pipe in concrete or use stronger pipe" indicates the advisability of laying all large pipe in concrete or else using double strength pipe. In the absence of experimental data as to which of these alternations is the stronger construction, the concrete is to be preferred, since it lends itself to the making of tighter joints, particularly where cement joints are used or in wet trenches. All sewer pipe up to, and including 12" diameter, commonly conforms to the accepted specifications for double strength pipe.

Concrete for this purpose need not be expensive. During November and December of 1913, 47 cu. yds. of a 1-5 hand-mixed gravel concrete was laid under about equal lengths of 15" and 20" pipe for an actual cost, including excavation for same, of $4.00 per cu. yd. Here the gravel cost $1.07 per yd. and cement $1.50 per barrel, delivered. Labor was 20 cents per hour. Very little foreman's time was included in the cost, since the work required practically no additional supervision. This cost does not include the removal of the excess material from the street, since in this case the earth was sold for the cost of removal. This figure would need to be increased in deep trenches where the cost of excavation was high or where the concrete could not be shovelled directly in place.

This sewer formed part of a storm sewer, the main outfall of which was 27" in diameter. On the outfall the cut was so shallow that it was feared a tile sewer would be broken under the weight of heavy rollers which it was expected to operate over the street preparatory to laying a pavement. Part of the sewer passing under railway tracks also required a stronger construction than tile. A concrete sewer 27" inside diam., 6" walls, with six ⅜" square bars placed longitudinally and spaced equidistant in the walls, was used as giving a stronger section. The structure was built of 1:4 gravel concrete and the interior was painted with grout. Some criticisms of this section were made by bidders as being too small to build economically of concrete. The cost as tabulated below indicate that the concrete sewer was built considerably cheaper than a single strength tile sewer laid on concrete could have been. The entire section of the sewer was run at one pouring, leaving no joints except at the end of each day's run.

Cost of 27" Concrete Sewer.

Item.		Amount.	Unit Cost.
	Labor.		
Laborers, Exc. and backfill,	677½ hours @ 20c.	$ 135.50	0.472 per cu. yd
Laborers, concreting.	510 " @ 20c.	102.00	1.46
Foreman, exc. and backfill,	58½ " @ 40c.	23.40	0.081
Foreman, concreting,	40 " @ 40c.	19.40	0.28
	Total	$280.30	$ 0.72 per ft
	Materials.		
Gravel,	70 cu. yd. @ $1.07	74.90	
Cement,	105 bbls. @ 1.50	157.50	
Forms,		64.85	
Miscellaneous supplies,		13.00	
	Total	$310.25	$ 0.82 per ft
	Total Labor and Material		1.52 per ft.

Results of hydrographic surveys conducted throughout the summer under the auspices of the naval service department, lead to the conclusion that first-class harbor facilities are to be found in James Bay in the vicinity of the mouth of the Nottaway River. Good shelter, ample room and a sufficient depth of water have been found and very little silt is in evidence to necessitate dredging. Soundings indicate plenty of water right out into the bay.

THE FUNCTIONS OF THE ENGINEERING SOCIETY.*

By L. K. Sherman,

President, Illinois Society of Engineers and Surveyors.

THE constitution of almost all engineering societies state that "the objects of the organization are the exchange of technical knowledge and experience and the advancement of the engineering profession." The benefits derived from the presentation of papers and the exchange of professional experience are of themselves ample reason for membership in the society, and incidentally they are large factors toward the professional advancement of engineering.

In my opinion, however, the time is now ripe when the engineering societies should enlarge their field of endeavor from the purely technical and literary functions to engage directly in efforts promoting the material status of the engineering profession and the individual members thereof.

I am not advocating this effort to promote the material status of engineers because of any alarming conditions. Engineering has advanced from a trade to a profession. Figures gathered by engineering societies, records of the graduates of technical schools and pay rolls of corporations show that the average annual income of the civil engineer to-day compares moderately well with similar statistics of the lawyer and doctor.

The field of the engineer has broadened, especially in lines of sanitation, highway construction and reclamation of lands. His position before the public is better recognized. Engineers are being placed as town managers, on public commissions, as investigators for financial corporations, and as constructors, instead of letting the work by contract.

It is, however, not our place merely to accept what the conditions of the times offer; it is our duty to take advantage of and to push those conditions which result in our rightful material welfare. This can be accomplished only through organization. This is the day of organization—individual effort fails. In business, consolidations alone survive. If engineers are to progress and to retain their rightful sphere they must do so through organization. The legal and medical professions are strongly organized to guard and advance their interests in legislation and in public relations. The architects of this State have an able organization, which legislated a certain kind of structural work out of our hands into theirs. Almost all lines of business have their lobbies. However much we may disagree with the methods of the building trades union we have to admire the efficiency of such organization. Some factors that have contributed toward the delinquency of engineers furthering their material welfare are their modesty, the fact that they are migratory animals, their false sense of dignity and too much conservatism. One of the unavoidable handicaps of the civil engineer arises from the very nature of his work. His work ends when the particular structure which he may be engaged on is completed. He then must seek other and often remote fields where new construction is to be started. These intervals between jobs are often of frequent occurrence. Thus the engineer is a migratory animal. I do not mean to underrate the desirability of maintaining the dignity of engineering as a profession, but dignity should not interfere

*Presidential address to the annual meeting of the society.

with business progress with us any more than it does with law or medicine.

I once heard of a secretary of an engineering society who was so conservative that he did not believe in any co-operation with the societies and in fact scarcely believed in a meeting of his own society.

The Illinois Society of Engineers and Surveyors has been one of the few engineering associations to enter the field of promoting material professional welfare. This society originated a movement to demand justice for a member engaged on a government bureau at Washington. Our action and his vindication were highly commended by the technical press, but the conservative constitutions of many engineering societies preclude this sort of work. During the past year a proposition was submitted at Springfield to place the State Geological Survey under the Board of the State University. This matter was brought to our attention and after consideration by the trustees and officers of this society it was decided that the proposed change would be detrimental to the efficiency of the Geological Survey, and communications were sent to a number of legislators at Springfield to that effect. The change was not made and the Survey maintains its separate existence.

After the passage of the law creating a State Public Utilities Commission, this society presented a petition to the Governor urging the appointment of an engineer upon said commission. Our membership is now honored with a member of the State Public Utilities Commission. In a number of instances the society has had special committees working in the interests of legislation affecting surveys and matters pertaining to land drainage and special assessment work.

The technical press of the country during the past year contains more communications than in any previous period on: "The Status of the Engineer"; "Compensation of Engineers"; "Engineers' License Laws"; "Code of Professional Ethics"; and "The Consolidation of the Engineer's Work in Large Engineering Corporations," etc. An association of consulting engineers in New York has been actually formed to handle these matters. The formation in Chicago of a Technical League, a union of engineers, associated with the American Federation of Labor, is a recent and most radical development. All of this is an indication that the engineering society is not entirely meeting the problems of material professional welfare.

Among the plans, projects and suggestions presented for advancing the status of engineers are: The licensing of engineers and surveyors; civil service laws; legal compensation for city engineers, etc.; trade unions; code of professional ethics; standardization of fees; and employment bureaus operated by the societies.

I cannot attempt here to consider the various arguments for and against these plans. What I am advocating here is that it is the proper duty and function of the engineering society to consider such plans, and to have an organization which possesses the necessary executive machinery to act upon those measures which are of benefit, and to circumvent those which are detrimental to the engineer and his allied works.

I recommend that the trustees and officers of this society be authorized to act as an executive committee in the name of the society in all matters of legislation and public relationship, and to receive, consider and act upon, or report upon, any complaint or suggestion presented by any member of the society. I also advocate the appointment of a committee on legislation whose duties it is to follow and to report to the executive committee any proposed state or municipal legislation which might be of interest.

The local or state engineering society is the logical organization to initiate such measures as are conducive to the material betterment of engineers. The efforts initiated by the local society should in turn be supported by the action of the interstate or national engineering societies.

The ability to accomplish practical results will to a large extent depend upon the numerical strength of the society. The voice of the society should be the representative voice of all engineers in the state. I believe that if the state society would acquire the reputation for action in measures affecting the status of the engineering profession and especially of its individual members there would be an immediate and large addition to its membership list.

POWER DEVELOPMENT AT GREAT FALLS, MAN.

Mr. Gano Dunn, president of the J. G. White Engineering Corporation of New York, was in Ottawa recently conferring with the Dominion Water Power Branch regarding the development of water power at Great Falls, on the Winnipeg River, in the province of Manitoba. This company has been retained by the Winnipeg River Power Company to design and construct a 100,000 horse-power plant at Great Falls. It is desired to have construction work commenced as soon as possible after the spring break-up, and an initial installation of 40,000 horse-power completed for use within three years.

The engineers of the Dominion Water Power Branch have recently completed an elaborate investigation of the Winnipeg River powers, and general conclusions have been arrived at with respect to the best method of concentrating the several natural falls of the river in order that there may be no portion of it left unused. As the Great Falls development must form a component part of the comprehensive scheme of concentrations arrived at by the Water Power Branch engineers, the J. G. White Company have made a thorough study of the Government investigations, and have decided to recommend to their clients, the Winnipeg River Power Company, that the Great Falls development should conform to, and be a component part of the Government proposals. Engineers of both the Water Power Branch and the company are in conference at Winnipeg and Ottawa in connection with the whole project with a view to having the necessary plans, specifications, etc., required by the Dominion regulations, submitted to the Department of the Interior for approval at the earliest possible date, in order that construction work may be commenced early.

The hearty approval by the J. G. White Corporation of the conclusions arrived at by the engineers of the Dominion Water Power Branch is a well-deserved tribute to the good work done by them in connection with important power possibilities of the Winnipeg River. This work has attracted a great deal of favorable attention, and the complete report of the investigations which will be published in the coming summer is awaited with great interest by all those interested in power development in Canada.

It is stated that the Western Railway of Buenos Ayres will eliminate all existing grade crossings and will electrify its suburban zone for a distance of about 25 miles from the terminal.

METHOD OF WELDING JOINTS IN CONTINUOUS STEEL GAS AND WATER MAINS AND OIL PIPE LINES.

THE material most commonly used for jointing water and gas mains is lead. For cast iron pipes, except where turned and bored joints are used, lead still holds the field undisputed excepting by a few patented lead compounds. Since the introduction of steel pipes with bell and spigot joints, lead has also been used for jointing steel pipes.

Since the perfection of oxy-acetylene welding, several attempts have been made to weld steel pipes together into continuous mains. Probably the most successful experiments of this sort have been those conducted by Stewarts and Lloyds, Limited, of England. This firm has patented a method of welding steel pipe joints that seems to have passed the experimental stage and to have become a commercial success.

Their joint consists of a spigot with a slight taper, which is drawn tightly into a faucet with a corresponding taper (see Fig. 5), the welding being effected by fusing soft Swedish charcoal iron wire with the metal of the spigot and faucet by the oxy-acetylene process. The close fit of the tapered surfaces of the spigot and faucet relieves the actual weld of any bending stresses which may come on the pipes.

Fig. 1.—Welder working underneath the joint.

The end of the faucet is slightly bellmouthed, and this bellmouth serves the threefold purpose of facilitating the entry of the spigot into the faucet, of affording a long contact surface for the weld, and of enabling the joint to be safely and easily made from either above or below the pipe without endangering the person of the welder.

Fig. 3.—Welder at work in position where it has been impossible to turn pipe so as to keep welding portion at the top. A recess was made to allow the welder sufficient space to work all around the joint.

The welding outfit consists of a supply of compressed oxygen, usually confined in steel cylinders holding 100 cubic feet, and an acetylene generator and gas holder, fitted with a purifier. To the oxygen cylinders are attached a reducing valve and two pressure recorders, one for recording the pressure in the cylinder, the other for recording the pressure at the outlet of the reducing valve. The carbide for making the acetylene is supplied in air-tight drums containing 100 lbs.

The acetylene generator, gas-holder and purifier and the oxygen cylinders are mounted on a small trolley which can be wheeled from joint to joint along the trench as the welding progresses.

In districts where few cross-pieces are encountered in the trenches it is usually most convenient, in dealing with pipes up to 6 in. and 8 in. internal diameter, to weld the joints above ground over a couple of trestles or timber triangles (see Fig. 4), one about 18 in. and the other

Fig. 2.—Stretch of pipe being lowered into trench after pipe has been welded above ground.

Fig. 4.—Six-inch pipe welded on trestles, then settling by its own weight into trench.

about 36 in. high, shifting the trestles forward a pipe length at a time, as each weld is completed, and allowing the finished part of the pipe line to settle down into the trench by its own weight, the pipes and joints being strong enough to make this method practicable.

Where the pipes must be threaded into position among numerous cross pipes, electric conduits, etc., the above method is impracticable. Under such circumstances some or all of the joints must be made in the trenches, without turning the pipes round, and to do this a recess about 6 feet long and 12 inches to 15 inches deep, under and in line with the pipe, must be provided at each joint for the welder, as shown in Fig. 3.

Where the trenches are straight and free from bracings it is practicable to weld up 6 to 12 pipes, depending on the diameter and conditions, either above ground (see Fig. 2) or in the trenches, without having a recess at every joint for the welder, the pipes being turned round as the welding of the joints proceeds. Two or more stretches having been welded up in this manner, these stretches can be welded together in the trenches, recesses for the welder being necessary, of course, at such welds, as shown in Fig. 1.

Joints occasionally occur in awkward positions, amid a labyrinth of other pipes. Welded joints in such positions may offer considerable difficulties, but the same applies to lead joints, the main difference being that to make a lead joint it is not always necessary to see it, but it is necessary to have sufficient space for the free use of the caulking tools and hammer. With welded joints, on the other hand, such clearance is often unnecessary, provided the welder can see the joint all round the pipe.

After welding, the joints can be tested with water or compressed air (see Fig. 6) before being put into service. In short lengths of main, or mains of small diameter, this can be done by means of a hand-operated pump, but where this would be too slow, a power-driven compressor can be employed.

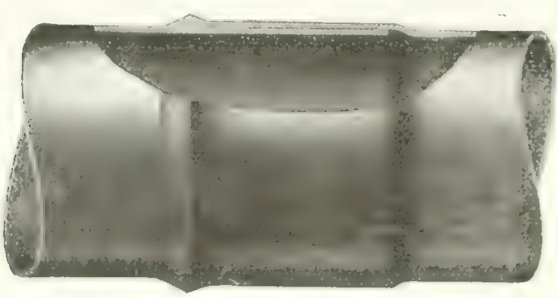

Fig. 5.—Welded socket and spigot joint.

When a main is being laid, the work is not delayed by the welding, as the welder, with his burner and rubber tubes, his gas outfit, a few bottles of oxygen and a small quantity of iron wire, will weld up at the rate of 150 feet of 4-inch main per hour, the pipe being in 20-foot lengths.

The cost of the joint under favorable conditions is said to be about the same as that of lead joints.

One of the objections commonly raised against welding long lengths of pipe into a continuous piece is that expansion and contraction due to variations in temperature may damage the joints.

In this connection interesting experiments were conducted by the patentees. A long straight pipe, held longitudinally and transversely against deformation, will be stressed to the extent of 2,240 lbs. per square inch of pipe section for every 10° F. variation in temperature. Tests of the patented joints showed a tensile strength of over 20 gross tons per square inch of pipe section. Under actual tests, variations of 80° F. did not affect the joints.

Fig. 6.—Testing main with compressed air to thirty pounds per square inch. Part of trench has been filled in, leaving only joints exposed.

A continuous stretch of these welded pipes, 4 inches internal diameter and 350 feet long, was embedded in a trench between two heavy concrete blocks and subjected to an air pressure of 100 lbs. per square inch, both ends being sealed. Throughout its entire length the temperature of this pipe was varied from day to day over a range of 80° F. for a month, the pipe ends meantime being kept rigid by the concrete abutments. At the end of the month the joints were as tight and sound as when first made.

Regarding the permanence of the joint under vibration, two 20-foot lengths, welded together and set horizontally, were vibrated by means of an eccentric with a 6-inch lift, revolving 300 to 400 times per hour, day and night, for a period of three weeks. After this severe treatment the joint was tested and was found sound and tight at 100 lbs. pressure.

When welding round the joint and coming back to the starting point, a small portion of the first weld is remelted to secure continuity in the weld. If this is not done a leak may develop at that point.

Steel pipes are coated outside and inside, or outside only, as required. The usual practice is to wrap the pipes, after the outside coating has been applied, in jute cloth saturated with solution. But, to avoid discomfort to the welder, the pipes are left free of coating and cloth for a distance of about 6 inches from each end, and a sufficient quantity of special solution for applying cold and hessian cloth for wrapping the joints after welding,

is supplied with each installation. The mains are thus not only welded up into one continuous length, but they are also provided with a continuous coating of anti-corrosive material, reinforced by a continuous envelope of cloth soaked in the same rust-resisting compound.

Steel pipes with this type of joint have been supplied for gas and water mains, and also for oil pipe lines, laid under water. In the latter case the pipes were paid out like a cable from a barge as the joints were made, and in a certain instance were welded on the bank and drawn in one length across a river a mile wide.

They have also been used for pump delivery mains in vertical pit shafts, the welding being done in the shaft, and in some cases on the pit head; the main, in the latter cases, being let down, a pipe at a time, as each joint was completed. The tensile stress on the joint, due to the weight of a vertical line of pipes 1,000 feet long, is equivalent to about 1½ gross tons per square inch of pipe section. As the joints have been found by tests to bear fifteen times this stress, the patentees state that this method of jointing may safely be adopted even for very deep shafts.

THE RELATION OF RAINFALL TO RUN-OFF IN AMERICAN RIVERS.

In a paper, published recently in the School of Mines Quarterly of Columbia University, Mr. W. F. White, Jr., assembles the available data on the rainfall and run-off in the various drainage basins of the United States, in an endeavor to determine what definite relations there exists between them. The following extract from his paper brings out also the factors that influence these relations, with their nature and relative importance:

The subject is one to which little study has been devoted, and the scarcity of written information is surprising considering the importance of the questions involved, in the development of both water power and water supply. The subject, furthermore, has a vital bearing upon the floods, which are of frequent and disastrous occurrence in some sections of the country. In the Am. Soc. C.E. Transactions are several papers with lengthy discussions which afford much valuable information on the actions of several individual streams and of the proportion of run-off from their catchment basins. The United States Geological Survey has taken up the study of rain and run-off, and in one of its bulletins G. W. Rafter sums up what is known of their relations. In addition, several water supply papers on various areas have given figures for the per cent. of rainfall appearing in stream flow, but have not gone more deeply into the causes of the variations for different times and streams.

Sir John Murray has published an article (Scottish Geographical Magazine, Vol. 3) on the amount of rainfall and run-off of the large rivers of the globe, and from them has assumed the ratio of run-off to rainfall for the world. He estimates that ratio is as 1 to 4.499, or about 22.2 per cent. of the precipitation. An interesting paper, "Ecoulement fluvial et Denudation," by H. Baulig, bearing more on the problems of denudation by streams, and on the chemical side, has recently appeared; with this, the list of papers on the relations of rainfall and run-off in the United States practically ends.

For the calculation of the ratios in this paper, the measurements have been taken for the years 1906 to 1910 inclusive. In this 5-year period a very good average of weather conditions is obtained, especially in regard to the precipitation. Of the five, two were of rather greater rainfall than is the ordinary experience, viz., 1907 and 1909; two were of less than average rainfall, namely, 1908 and 1910; and one, 1906, was of nearly average amount. These statements can be made, however, only in a general way, and the mistake must not arise of assuming that any one section of the country had precipitation of more than average amount, because the country as a whole had a year of heavy rainfall. Thus, though the year 1907 had generally a much heavier rainfall than 1908, yet locally, as in the southeastern states, the latter year records the heavier precipitation. This goes to show that the rainfall is a very uncertain quantity, and makes difficult the task of determining the amount at one point of comparison with that of some other region.

The amount of rainfall even in one place shows surprising variation from year to year. In general, the maximum annual total is from two to four times the minimum. Thus, at Orono, Me., a record for 42 years gives a minimum annual precipitation of 28.5 in. in 1895, and a maximum of 58.7 in. in 1888, or a ratio of 1 to 2.1. At Boston a record for 74 years shows extremes of 27.2 in. and 67.7 in., or a ratio of 1 to 2.5, slightly greater than at Orono. The mean annual rainfall for the whole United States amounts to 29.4 in., but, due to the extreme variability for different places and times, gives no clue to the rainfall of any particular area.

The distribution of the rainfall through the year also varies greatly in different sections of the country. The precipitation may be fairly uniform throughout the year, as in the New England states, where the mean of a period of years showed that 12.2 in. of rain fell in spring, 11.4 in. fell in summer, 11.7 in. fell in autumn, and 11.7 in. fell in winter. On the other hand, the precipitation may be nearly all crowded into one period, as is commonly the case along the Pacific Coast, where, in the Sacramento Valley, 83 per cent. of the annual precipitation falls in the period from November to April.

When rain falls on the surface of the earth it may do one of four things: It may be evaporated directly by the sun; it may flow directly into streams or lakes; it may sink into the ground; or it may be taken up by vegetation or combine with minerals of the earth's crust. The part that is evaporated by the sun is lost, and no further consideration of it need be made. The quantity of water which finds its way directly to streams varies greatly with the time of year and the nature of the country. It is much higher in winter, when the ground is frozen, than in summer, when the rain has a chance to sink into the ground. This part constitutes what is known as surface flow.

That part which sinks into the ground is by far the greatest and most important, though it, too, varies with the nature of the soil. In a sandy, porous soil the amount will be very high, while in an impervious, clay soil it will be comparatively slight. This underground water serves as a source of supply in times of drought. It may reach the surface in springs, wells, or by seepage. This last is of the greatest importance, and, when it is considerable, serves to keep the flow of the streams uniform throughout the year. When it comes to the surface it is again exposed to evaporation and is partly removed in that way. With the exception of a negligible amount which sinks into the earth and is not recovered, this water finally is returned either as stream flow or evaporation.

Of the part that is consumed by vegetation, some is lost, but a considerable proportion is returned to the atmosphere by evaporation from leaves and other surfaces. Thus a very large part, which has been estimated

at over 99%, is ultimately delivered back in the form of stream flow and evaporation. It is with stream discharge, or the run-off from a catchment basin, that we have specially to deal. The amount of this depends primarily on the precipitation, for without this there could be no run-off; yet there are many other factors which influence the flow, and create very complex relations.

The flow of streams has been divided into the following periods: Storage, growing, and replenishing. The storage period for the eastern United States begins about December, though it may vary from year to year and in different localities, and concludes about May. During much of this time, evaporation is slight and the demands of vegetation are small, so that a large percentage of the rainfall reaches the streams. The growing period includes approximately the months from June to August, during which time both absorption by plant life and evaporation are at a maximum. As a result, the amount of rainfall that finds its way to the streams is small, and the streams have their minimum flow unless a very rainy season upsets the customary conditions. During this period, the drain on the underground water supply is severe and the level of the ground water falls. During the replenishing period, which lasts from September to November, the flow assumes more normal conditions, and the run-off is higher than during the growing period. The ground water regains its former height, and by the beginning of the next storage period everything is in favorable condition for a large stream flow.

The method used in calculating the precipitation of each basin was to select such stations of the United States Weather Bureau as were within it, and from them to pick out a number from the different sections of the basin, which would show the average conditions. From the records of these, it was possible to arrive at an approximation of the mean annual rainfall for the basin in question. The number of stations selected necessarily varied widely with different basins. In a small basin, with comparatively uniform conditions throughout, a few stations sufficed, while in a long basin, with widely varying conditions, such as that of the Columbia River, a greater number of records was required to determine the mean precipitation.

The stream measurements are those secured by the government at its gauging stations on the different rivers. The volume of the discharge is computed by securing a profile of the stream bed at the gauging point, and then placing on some permanent object a gauge which will read the height of the water. Daily readings are taken to ascertain the cross-section of the stream, while the speed of the current is determined with a current meter. After a number of discharges have been computed, a rating curve can be drawn which will give the discharge directly from the gauge height. Where the gauge is at a dam or weir, somewhat different methods are used, the flow being calculated by formula. Unfortunately, these gauging stations are rarely at the mouths of streams, and as the run-off for the entire drainage basin of the stream is not given, care must be taken to specify above what point the data apply.

Steam discharge is commonly given either as foot-seconds of flow, which is the number of cubic feet passing a given point in a second; or as the average total inches in depth of water flowing from the entire drainage surface during a stated length of time. This latter method has been followed in this paper, in order that the results may be directly comparable with the precipitation records.

Rainfall measurements are always given in inches of depth during a stated time, usually a year. Accordingly, the precipitation of an entire drainage basin is expressed in inches over its area.

The sources of error in precipitation records are several. In the first place, a rain gauge can cover only a few square inches of ground, and to obtain accurate results a large number of gauges in the same district would be necessary, which is usually impracticable. The elevation of the gauge above the ground also has an important bearing on the accuracy of the measurements. The gauges should be kept as near the ground as possible, whence records of rainfall taken on the tops of buildings are of little value.

The fact that many streams have their headwaters in the mountains adds to the difficulty of securing reliable records, as there are few stations in the mountainous regions, and these are generally confined to the valleys.

The accuracy of stream measurements depends upon the type of gauge used. If at a weir or dam, reliable measurements can be obtained, generally within an error of five per cent. At other gauging stations the results are not always so accurate, and the error may range up to 20 per cent. in exceptional cases. The main cause of this trouble is the constant shifting of the bottom, which renders the cross-section used in the computations inaccurate unless frequently corrected.

The data in the tables accompanying Mr. White's article were compiled in this manner: Following the name of the river comes that of the gauging station above which the data are computed. In the third column is stated the area of each river basin in square miles, and in the fourth the percentage which each basin constitutes of the whole drainage district. This is done for the purpose of giving due weight to the larger streams. The fifth column records the average annual rainfall of each basin, in inches, during the five years 1906 to 1910 inclusive, except in a few cases in which the average is based on only three or four of these years. The sixth column gives the annual run-off of each basin, averaged on the same five years; the figures represent inches in depth over the area of the basin above the gauging point. The ratio in the seventh column is obtained by dividing the average run-off by the average rainfall for the five years, not by averaging the ratios of the five years. The product in the last column is computed by multiplying the percentage area of each basin by its average ratio; hence the sum of this column represents the mean run-off ratio of the district.

It was found convenient to follow the divisions of the country made by the Geological Survey, and the streams have accordingly been grouped into the following districts: North Atlantic; South Atlantic and East Gulf of Mexico; Ohio River; St. Lawrence River; Upper Mississippi River; Hudson's Bay; Missouri River; Lower Mississippi River; Western Gulf of Mexico; Colorado River; Great Basin; Pacific Coast in California; North Pacific Coast.

From a study of the tables and a consideration of the basins of the individual rivers, some conclusions can be derived as to the various factors determining the run-off of a stream. The influences operating on the discharge of a river basin are too intimately associated and involved to allow an exact statement as to their respective importance, but certain general relations can be shown, and the relative importance of the factors judged approximately.

Run-off is, of course, primarily dependent on precipitation, but to say that the run-off varies directly as the rainfall is a broad statement which statistics fail to support. This is true, not only for different drainage basins,

but even in the same basin. Thus in the Penobscot River, above Millinocket, Me., in 1906, with a rainfall of 41.9 in., there was a run-off of 18 in., or 43 per cent., while during the next year, with a rainfall of 42.1 in., the run-off was 26.9 in., or a ratio of 64 per cent. Cases so extreme as this, however, are of unusual occurrence and are due to outside influences. Ordinarily it can safely be said that the per cent. of run-off in any particular stream will increase with an increase in rainfall. This is well illustrated by the Columbia River, which shows the following variation:

Year.	Rainfall.	Run-off ratio.
1906	21.5	45.6%
1908	24.2	49.0
1909	24.1	50.2
1907	26.1	52.1

Even though varying with the rainfall, the run-off is not directly proportional to it, but shows much greater variation than the rainfall ever does. The maximum annual rainfall rarely exceeds four times the minimum, while the maximum run-off may exceed the minimum by several times that amount. If the rainfall and run-off should be plotted for a period of years on an equal scale, the curve of the rainfall would be found to be much the more irregular, with far sharper changes. An example of this is given by the Oconee River, above Dublin, Ga.:

Year.	Rainfall.	Run-off.	Ratio.
1906	50.1	19.6	.391
1907	45.9	14.7	.319
1908	54.3	25.2	.464
1909	49.1	18.2	.369
1910	43.3	12.4	.288

Of even greater importance than the total amount of the rainfall is its distribution throughout the year. A stream which has its precipitation concentrated in a few months will yield a higher percentage of run-off than a similar one with its precipitation distributed evenly throughout the year. The causes for this are apparent. In the former case, evaporation has a smaller opportunity to act on the water, since in a rainy season evaporation is at its poorest efficiency. Also, as the ground can hold only a certain amount of water, when it becomes saturated the remaining water can flow off as a surface discharge.

An example of this principle can be found in the Merrimac of Massachusetts and the Kaweah of California. With nearly equal annual rainfall of about 32 in., the Kaweah has 33 per cent. higher run-off, the ratios being respectively 0.514 and 0.714. This is due to the concentration of 83 per cent. of its total rainfall into the months from November to April, while in the Merrimac basin the precipitation is distributed very nearly equally throughout the year, with 26 per cent. falling in spring, 24 per cent. in summer, 25 per cent. in autumn, and 25 per cent. in winter. This distribution of the rainfall is of the greatest importance, and special emphasis should be placed on it in calculating water supplies.

One reason for the increase in the ratio of run-off with higher rainfall is found in the evaporation, which remains nearly constant from year to year, irrespective of the amount of precipitation. The explanation of this is that conditions favorable for high evaporation, i.e., heavy rainfall and high temperature, rarely occur together. Due to this the evaporation of a wet year is about equal in amount to that of a dry, hot year. This uniformity of evaporation, so noticeable as between years, is not found as between seasons of a single year, when, on the contrary, great differences occur. In the basin of the Sudbury River of Massachusetts, evaporation during the summer is six times as great as during the winter, owing chiefly to the higher temperature and greater amount of sunshine during the former, and to the occurrence of ice during the latter season.

The evaporation of different streams varies widely, being dependent upon a number of separate factors. The most important of these is the temperature. Evaporation is directly proportional to the temperature, and will therefore be higher in warmer regions, other things being equal. It is even sufficient, in very hot regions, as some parts of the Great Basin, completely to exhaust the streams, leaving no flow in the river bed. The velocity of the wind also has an important influence on evaporation. Other factors of major importance are the roughness of the surface, the amount of sunshine, and the area forested.

Numerous attempts have been made to construct formulas by which to compute the run-off of streams from the precipitation records. Several of these are in use, but they are inaccurate and require important modifications for each stream. A formula for one stream may give fair results for a neighboring one of similar character, but to apply it to a stream in a different section of the country would be futile. The only reliable way to ascertain the run-off from rainfall data is to construct a curve for the particular stream from the records of former years, and use it as a standard.

The influence of topography on run-off is hard to gauge, as it is closely associated with other factors. It is probable, though, that this is one of the less important agents in determining stream flow. Roughly, it may be stated that in a steep basin the run-off will be large but very irregular, while in a flat basin the run-off will be less, but more uniform.

Two streams which flow over the same geological formation will be found to have a close resemblance in flow. The character of the soil and underlying rock is chiefly important by its ability to hold the rain in the form of ground water. Igneous and other massive rocks, such as the pre-Cambrics of the upper Hudson valley, give little opportunity for the rain to penetrate them, and therefore yield a relatively high run-off. At the other extreme, very porous rocks, as some sandstones and highly jointed limestones, yield little or no surface flow, but conduct the water at a deeper level, returning it to the surface at a lower point, possibly in some other drainage basin. These rocks afford a more regular flow to the streams, but the opportunities for loss are greater, and the ultimate total run-off is somewhat less than where denser rocks occur. Likewise a sandy surface soil yields a more uniform but smaller flow than where the soil is clay.

An interesting example of the influence of geological formation on the run-off is found in the basin of the Mohawk River, where those tributaries flowing from the granitic area to the north of the stream have a greater run-off than those coming from the Devonian shales to the south. It must not be forgotten, however, that the area to the north is much more heavily forested, and its greater flow is undoubtedly partly due to this influence.

The proportion of a drainage basin that consists of lakes and marshes has a modifying influence on stream flow, through the ability of these to store excessive rain-

fall and to distribute its flow over a longer period of time. On the other hand, due to increased evaporation over a water surface, lake area decreases the total run-off of a basin to an appreciable extent. An example of high evaporation is seen in the Oswego River basin, of which 10.6 per cent. consists of lakes and marshes, where the evaporation amounts to 28 in. annually. The equalizing effect of lakes on stream run-off is also well illustrated in the basin of the Androscoggin River, which has 69 square miles of lake surface.

Lakes and marshes are not the only means of storage, for over most of the country large quantities are stored in the form or ice and snow, occurring as loose drifts in the lowland, which will melt and will find their way to the streams at the first thaw, or as deep solid drifts on the mountain ranges, or more rarely in the form of permanent glaciers. Snow of the first type serves only to swell the already high streams of early spring, without having any beneficial character. If of the latter types, the melting period is much later and more protracted, which is of great service in maintaining flow during the summer months when all other agencies are working toward the reduction of the discharge. It is a general rule that streams which have their sources in the mountains maintain a more constant summer flow than those rising in the lowlands. Nowhere is this better illustrated than in the streams of the Pacific Coast, where the mountains of the Coast Range are close at hand, and contain the headwaters of most of the streams.

That the vegetation of a drainage basin is of great importance in determining the amount of run-off is generally accepted, but whether the forests increase annual rainfall, as commonly believed, has not been proved. Indeed, it is now considered very doubtful whether any difference in rainfall can be traced to the influence of vegetation. The real value of vegetation, and particularly of forest growth, is in restricting the evaporation of the rain that does fall. Plants somewhat counterbalance their effectiveness in this direction by the water which they consume themselves, but the balance is well in their favor; and if, of two similar watersheds, one is heavily forested and the other is not, the run-off from the forested basin will exceed that from the other.

The effectiveness of the vegetation depends largely upon its character. The best type is old coniferous forests which allow little wind and less sunshine to penetrate their depths. Where extensive areas of such forests occur the run-off is sure to be high. Deciduous growth is not so influential, yet is still of value, and even cultivated fields are of some, though limited importance. The means by which the increased run-off is produced are several. First is the restriction of evaporation, due to the inability of the wind to circulate freely among the trees, to the maintenance of lower temperature and higher humidity during the summer months, and to the protection which the foliage gives from the sunshine. Aside from the lessening of evaporation, forests provide conditions favorable for the accumulation of snow drifts and their preservation until after the time of the spring floods. The ground-water circulation is also increased by forests. Examples of high run-off from heavily forested regions are common, but the Machias, Mohawk and Umpqua Rivers are excellent illustrations.

In spite of the prominence of forests in governing the run-off from an area, other factors may combine to overcome its influence; as a result, some basins show low or irregular run-off notwithstanding their being heavily forested. This is well shown by the streams of western Oregon and Washington, which, although well protected by forests, are subject to floods, due to heavy and concentrated rainfall.

The recent disasters in Ohio and Indiana have brought the general subject of floods prominently before the public mind, and the study of their causes and occurrence is of special interest. It has been noticed of late years that floods have been increasing in frequency and a study of the records of almost any stream subject to floods will prove this. On the Allegheny River, during the period from 1874 to 1890, floods occurred in only three years, while during an equal period, from 1891 to 1907, there were ten years when floods occurred. Likewise, on the Savannah River, from 1876 to 1890, there were three years with floods; while during the years 1892 to 1906, there were five years with floods. These rivers indicate fairly well the change in conditions throughout the eastern states.

The explanation of this increase must lie in a change of one of the influences governing run-off. Records show that rainfall and temperature have not changed; the topography and geology of a river basin are permanent, for this discussion; artificial agencies tend to check rather than encourage floods; hence the prime cause must be a change in vegetation, chiefly deforestation. The records sustain this supposition by proving that it is those very basins that have been most denuded of their forests which record the greatest increase in the number of floods. Thus, on both the Allegheny and the Savannah river basins large lumbering industries have been at work during recent years, and the increase in the number of floods can be traced directly to this cause.

In conclusion is should be emphasized that the solution of the problems herein discussed is not final, because reliable records over long periods of time are not available, and little attention has yet been paid to this important subject.

In a report made by State Engineer Bensel, it is announced that New York State will have invested in its barge canal, when complete, $86,000,000, an increase of nearly $10,000,000 over the original estimate in 1913. He recommends also that the United States federal government be asked to deepen United States waters at Oswego, Albany and Whitehall; and favors also the conversion of all old canal lands into boulevards and parks.

L. R. Grabill, superintendent of suburban good roads, Washington, D.C., considers that the prime factors which should determine the selection of a type of road surface, when selection is not limited by any necessity for giving undue preference to any factor, are; first, the volume and nature of the probable traffic over the pavement; secondly, conditions incident to the location of the pavement; including the character of the adjacent land and improvements, the character of the foundation, the kind of adjoining pavements, the ruling gradients, the climatic conditions and especially the availability and cost of different materials at the work; thirdly, the characteristic of the surface which will adequately meet physically, hygenically and aesthetically the conditions expressed in the two factors first named; and last, the quotient obtained by dividing the total estimated traffic to be carried per unit of width into the cost per unit of area of the pavement during its probable life; including first cost and interest on the same, special surface treatment for dust suppression or other purposes, and any necessary repair until replacement; but not including the cost of cleaning.

WATER POWERS OF MANITOBA.

THAT Manitoba is richly endowed with numerous water-powers has been generally known, but previous to the investigations of the Water Power Branch of the Department of the Interior of Canada, their extent and magnitude have only been approximated. Recognizing the great value of such powers, and with a view to the power requirements of both the present and future, a complete study has been made of certain power rivers, and is being made of all other power rivers throughout the province. In such studies it is the aim of the Department to form a comprehensive scheme contemplating the maximum development of the total head available upon a river.

A general summary of the water-power resources of the province forms a part of a report prepared recently by the Department for the Public Utilities Commission of Manitoba. The information given here is extracted from the report. *The Canadian Engineer* for February 12th, 1914, published another portion dealing with the power possibilities of the Winnipeg River as a part of the same investigations.

The preparation of the material in the report, with the exception of that relating to the Winnipeg River, was commenced by Mr. D. L. McLean, Chief Engineer of the Manitoba Hydrographic and Power Surveys. Owing to his resignation in October last, most of the work devolved upon the assistant engineer, Mr. S. S. Scovil, whose enthusiastic co-operation made possible the speedy completion of the whole, in order that it might be in the hands of the Public Utilities Commission by December 15th, 1913.

The great power possibilities of Manitoba are due to the geological and topographical features of the province. The central portion of Manitoba acts as a collecting basin for the waters from an immense drainage area. This vast area extends from the Rocky Mountains practically as far eastward as Lake Superior; it also comprises a great portion of the Northern States and reaches into the northerly lands of Western Canada.

As these waters reach the central portion of the province, a depression occurs between the prairie steeps and the Laurentian plateau, through which an extensive fall is available for power development. Lake Winnipeg forms the reservoir into which is collected practically all the runoff from the above drainage area. From this lake to Hudson Bay the flow is concentrated in the Nelson river, on which a drop of approximately 700 feet occurs.

It is thus apparent that the major portion of the powers throughout the basin are concentrated within the lower portion of the drainage area, or more particularly in Manitoba.

The powers are naturally separated into two divisions, viz., those occurring on the rivers draining into Lake Winnipeg, which are situated in the older or southern portion of the province; and secondly, the powers which occur in the northern portion lying in the drainage from Lake Winnipeg. Under these two divisions the estimated powers of the province are tabulated below.

It should be noted that while on many rivers, possible power concentrations have been investigated, and an estimate of the available power is given for various sites, yet, as future investigations will show, further power may be available on such rivers. Again, in the case of other rivers, no surveys to determine the extent of concentration available have as yet been made, and in these cases where a record of the flow has been obtained, an estimate is made of the power available per foot head. In many cases the power has been estimated both for the extreme minimum flow and for the lowest monthly mean flow of the highest six months of the year as obtained from the present record of discharges.

The horse-power has been calculated for a turbine efficiency of 80 per cent., while no estimate has been made as to the power available during short periods of high or peak loads, since this would be impossible without a knowledge of the circumstances for which the power might be desired. The powers on the Winnipeg river have been considered on a 75 per cent. efficiency basis for reasons set out in the treatment of that river. (See *The Canadian Engineer*, February 12th, 1914.)

The data for these tables, and also for the more detailed description of the rivers as given in the following chapters, has been secured in the field by the Manitoba Hydrographic and Power Surveys, and office compilation in Winnipeg and Ottawa.

The following tabulation of the powers in the province is not intended to fully cover the subject, as many rivers are as yet to be investigated:—

POWERS OF SOUTHERN AND CENTRAL PORTION OF PROVINCE.

Table No. 1.—Existing Water Power Developments.

River.	Plant.	Power developed. H.P.
Winnipeg	City of Winnipeg*	20,800
Winnipeg	Winnipeg Elec. Ry. Co. ..	26,500
Little Saskatchewan.	Brandon Elec. Light Co..	500
Little Saskatchewan.	Minnedosa Power Co. ..	500
Shell	Assessippi	50
	Total	48,350

*The city of Winnipeg's plant can ultimately supply, with a regulated river, 76,800 24 hr. power.

Table No. 2.—Possible Water Power Developments.

Winnipeg River.

Site.	Head.	24 hr. power at 75% efficiency. 12,000 sec. ft.	20,000 sec. ft.
Slave Falls	26	26,600	44,400
1st site Seven Sisters ...	39	11,600	34,800
2nd site Seven Sisters ...	37	12,600	37,900
McArthur	18	18,400	30,700
Du Bonnet ...	56	57,300	95,500
Pine	37	37,900	63,100
Total		164,400	306,400

Table No. 3.

Horse-Power on 80% Efficiency 24 hr.

River.	Site.	Min. flow.	Total	Reg. flow.	Total	Period of 6 highest mos. of yr.	Total.
Whitemouth	No. 1	[illegible]	..	..	...	180	....
	No. 2	46	[illegible]	..	.	180	360
Brokenhead	X	[illegible]	.	..	....	8	...
Roseau	X	0	...	..	..	[illegible]	...
Red	St. Andrews		.	..	...	3,270	3,270
Pembina	X			..	....	...	....
Souris	X	0.5	.	.	....	4.5	....
Shell	X		.	..	...	18	..
Assiniboine	Currie's Landing	[illegible]	..	..	..	1,685	1,685
X	Headingly	[illegible]	.	.	...	[illegible]	....
X	Millwood	14	...	..	...	64	.
Little Sask	No. 1	[illegible]	....	840	.		..
	No. 2	[illegible]		[illegible]			..
	No. 3	[illegible]	....	987			...
	No. 4	[illegible]	685	420	3,102	...	....
Valley	No. 1	34	....	102	...	172	....
	No. 2	[illegible]	....	102	....	172	...
	No. 3	[illegible]	....	303	.	504	....
	No. 4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1,316

Table No. 3.

		Horse-Power on 80	Efficiency 24 hr.				
Mossy	No. 1	272	....	..	....	....	....
	No. 2	272	544	..	....	....	....
Waterhen	Meadow Fort	6,800	....	..	....	....	....
Fairford and Dauphin	No. 1	3,030	....	..	....	....	....
	No. 2	2,150	....	..	....	....	....
	No. 3	12,[illegible]	..	.	....	....	....
	No. 4	7,260	26,546	..	....	....	....
Swan River	X	[illegible]			.	1[illegible]5	....
Red Deer	X	[illegible]	....	..	....	....	....
Manigotagan	No. 1	[illegible]	..	449	....	....	....
	No. 2	22		109	....	...	....
	No. 3	[illegible]	.	163	....	....	....
	No. 4	82	..	408	....	....	....
	No. 5	[illegible]	..	163	....	.	....
	No. 6	49	.	245	....	..	....
	No. 7	92		462	....	...	....
	No. 8	76	..	381	....	...	....
	No. 9	57	.	286	....	....	....
	No. 10	74	608	368	3,034	....	....
Saskatchewan	Demi Charge	6,808	..	..	....	46,289	...
	Red Rock	6,808		..	.	46,289	
	Grand Rapids	36,[illegible]5	40,021	..	....	246,877	339,455

The estimated power as shown refers only to horse-power per ft. head as investigations as to possible concentrations are as yet to be made.

POWERS OF NORTHERN PORTION OF PROVINCE.

Table No. 4.—Nelson River.

Site.	Horse-Power Based on 80 Efficiency. (Est. Min. Flow, 50,000 sec. ft.)
Whisky Jack Portage	181,150
Ebb and Flow Rapids	77,150
White Mud Rapids	135,860
Bladder Rapids	90,575
Chain of Rock Rapids	158,510
Devils Rapids	113,220
Grand Rapids	122,530
Birthday Rapids	163,375
First Gull Rapids	77,150
Second Gull Rapids	95,105
Third Gull Rapids	90,575
Fourth Gull Rapids	135,860
First Kettle Rapids	77,150
Second Kettle Rapids	97,370
Third Kettle Rapids	181,150
Upper Long Spruce Rapids	181,150
Upper Long Spruce Rapids	235,495
Upper Limestone Rapids	149,450
Lower Limestone Rapids	185,680
	2,548,505

During 1912, a thorough study of the advisability of paying close attention to the air consumption of the machine drills in a mine, especially where power is purchased, as shown by the experience of the Central Mining-Rand Mines group on the Transvaal (Journ. So. African Inst. of Eng., November, 1913), was made; and the new methods of handling the machines was adopted. The air consumption for all purposes underground was reduced to units of 3¼-in.-piston drill shifts. The average number of such units was between 75,000 and 80,000 per month over the year. The air was purchased in so-called air units, representing energy to the extent of 0.641 kilowatt-hours. The consumption of these units was about 11,500,000 per month and the average consumption per machine shift was reduced from 163 to 138. This represents a clean saving of $0.25 per machine shift, over $225,000 in a year's time. This would seem worth while.

CONSERVATION OF COAL IN CANADA.

The Commission of Conservation has now in press a report on the conservation of coal, according to the address of Hon. Clifford Sifton, at the last annual meeting of the Commission. This report catalogues briefly the methods followed in operating the principal coal mines of Canada. Emphasis is laid on the advantages of the leasehold system of granting coal areas which is in vogue in Nova Scotia, and the adoption of a similar system is recommended in other provinces, more especially in Alberta, with a view to stopping the wasteful methods of mining coal which obtain in certain districts.

Attention is also directed to the advantage of briquetting coal, in order to prevent the waste of slack; and the advantages of the by-product coke, even over the type generally in use, are set forth.

The fact that the practice of briquetting coal has not yet been followed on any considerable scale in Canada is an illustration of the difficulty of securing the introduction of well-proved, economic methods which have been in use in older countries for many years. It is hoped that a beneficial change in this respect will come about in a short time.

In addition to visiting the different mining plants for the purpose of getting information upon which the report respecting the conservation of coal is based, W. J. Dick, B.Sc., Mining Engineer of the Commission, in acting as guide in connection with the visits of the International Geological Congress to the coal mines of western Canada, had the benefit of gaining the opinions of foreign scientists in regard to the conduct of the coal mining industry.

NEW PULP MILL ON THE ST. LAWRENCE.

On the south side of the Gulf of St. Lawrence, about sixty miles back from the end of land, the St. Lawrence Pulp and Lumber Corporation is erecting a plant which, when finished, will represent an investment of close to a million dollars. There is an irregular group of buildings, mostly one-story, and measuring something like 900 by 200 ft. in plan, forming a complete pulp mill for making high-grade bleached sulphite pulp, together with a digester building covering digesters reaching 160 ft. above the ground. All of this is now being built by the Aberthaw Construction Company, of Boston, and is to be finished by next September. The buildings have concrete exterior, the interior structure being largely of structural steel, with yellow pine roofs.

There is to be an independent steam turbo-generator plant, giving power for both the pulp mill and a saw mill, which is being erected separately. A private railroad is to supply the mill with logs from the extensive timber and pulp-wood limits of the company, aggregating some 500 square miles. The Dominion Government has undertaken to develop a harbor for safe wharfage for ships up to 6,000 tons burden.

Canadians may praise the condition of English roads, but the following facts show the Englishmen see plenty of room for improvement. Proceeds of the petrol tax are enabling seven counties to spend $4,000,000 this winter, on road making, with the object of creating a smooth, waterproof, dustless surface. The road board, which Mr. Lloyd George created, has already made grants of $22,500,000 from the imperial taxation for strengthening the main roads to meet the requirements of modern traffic.

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OTTAWA'S TEST FOR INTELLIGENCE.

A plebiscite on a question of civic concern cannot be said to achieve its purpose unless the voter has a clear conception of its fundamentals in order that he may poll his vote in accordance with his convictions created thereby. To be able to vote intelligently is the chief desire of every enfranchised citizen. A city council should assist the ratepayer to a clear understanding of the projects it may have under consideration, especially when it contemplates acting according to the vote of the citizens. Perhaps a more illustrative instance could not readily be found of a city council taking for granted that the man on the street can weigh and judge, with competence, questions which tax the agile and discriminating capabilities of the experienced engineer, than that which has appeared in connection with the Ottawa water supply situation. The city's serious position has brought forth reports from engineering experts on five separate proposals. They have appeared at intervals during the past 3½ years. Each in turn was subjected to a round of discussion and criticism which left the layman in such a quandary that the water supply situation has continued substantially unchanged.

On March 9th, the citizens will vote upon the acceptance of any one of the five schemes or the rejection of them all. The reports upon them are being presented in their entirety through the medium of the daily press. They occupy 4½ closely printed newspaper pages. The ratepayer is supposed to select the scheme best adapted to the needs, and likewise the finances, of the city. He is obviously expected to appreciate the significance of each, to differentiate between considerations of purification, precipitation, run-off, pipe line construction, pumping installations, future population, annual operating costs, fixed charges, etc. Then he is supposed to place himself on record as being in favor of one and against the others, influenced only by his own intelligent comparison.

Rather than subject each ratepayer to an ordeal which he is quite incapable of satisfactorily accomplishing, how much better it would have been for the City Council of Ottawa to have engaged a consulting engineer to condense and standardize the voluminous reports so that the citizens could then make an intelligent comparison and understand the meaning of their vote. This, however, is what the City Council considered and decided not to do.

THE KINEMATOGRAPH IN SCIENTIFIC RESEARCH.

Professor Anderson, of the University of Toronto, has favored us with an interesting description of the newly installed kinematograph which will add materially to the facilities at the University for exhaustive scientific research. The article on page 415 of this issue will doubtless be found very instructive by our readers, many of whom can realize at once the important bearing such an apparatus will have in many of the studies which enter into university training.

The very great importance of visualization in teaching is so universally recognized that projecting lanterns form a most important part of the equipment of every scientific institution in the country, and every lecturer who wishes to make his subject clear and attractive feels bound to provide plenty of pictorial illustration. However, it must be admitted that while the stationary picture

forms an invaluable adjunct to a description of an object, be that what it may, that picture fails to convey any adequate idea of a process, of an event, of machinery in motion, of people in action, in short of life in general. The photograph exhibits all life and motion as instantly arrested—a sort of cold-storage representation, if one may use the expression.

With the kinematograph, however, all is different, and we see representations of events taking place, of processes being carried on, of machinery in motion and of people moving about as in actual life. Perhaps it is not too much to say that the kinematograph is as great an advance on the stationary lantern slide or photograph as the latter was on the laborious written descriptions that preceded the discovery of photography.

There is not a branch of scientific work in which this facile method of illustration may not be used with the greatest advantage. In elementary education where the child learns most readily through observation, we may use moving pictures to teach history and geography, to illustrate manual training and handicrafts of all sorts. In more advanced work, engineering in all its branches offers a fruitful field for this method. In the laboratory we may take records of tests of all sorts and study every phase of the reaction at leisure afterwards; industrial plants may be photographed and exhibited in action in the class room; field operations of all kinds may be similarly shown. In the domain of medicine there is also abundant scope for the moving picture, whether we are dealing with objects of large size or minute organisms that are only visible through the microscope. In military operations or naval manoeuvres there is likewise an ample field of usefulness for this method. The naturalist will welcome the kinematograph as an unrivalled method of studying and illustrating the habits and motions of animals and the growth of plants. Many other possibilities will no doubt occur to the reader, but enough has been indicated to show the universality of the motion picture in educational work and it is not too much to predict that we shall soon see every technical school and university equipped with a paraphernalia for this work as the University of Toronto has been equipped.

ELECTRICITY IN BLASTING OPERATIONS.

Electric ignition in the blasting of charges in mining, tunnelling and similar operations, has greatly assisted in the prevention of accident and disease by permitting the withdrawal of operators from the sphere of danger. Not only from the explosion itself but from the dangerous gases which follow perfect or imperfect detonation, does it afford more and better opportunities for safety, thereby becoming a factor of great importance. When blasting gelatine has been properly detonated the products are chiefly CO_2, H_2O and N_2. If it is merely burnt the products of combustion are CO_2, CO, N_2 and NO. In either case the carbon dioxide causes asphyxiation; carbon monoxide is a strong poison, and the nitrogen compounds, if inhaled, cause intense irritation of the air passages, bronchitis and pneumonia.

In a properly organized system of electric ignition, blasting accidents are reduced to a minimum, and the underground worker is requested to withdraw to a place of safety before a single shot is fired.

The introduction of the ignition of blasting charges by electricity is a subject that appeals to engineers, it being associated with the history of electrical engineering itself. After the discovery of the primary cell by Volta, the thermal effect obtained by interposing in the circuit of a Voltaic battery a short piece of wire of high resistance was noticed by Professor Hare about 1822. This discovery was immediately used as a means whereby blasting charges could be exploded.

The discovery by Dr. Oerstedt in the year 1820 that a magnetic needle tended to place itself at right angles to a current of electricity, and the subsequent development of this discovery by Faraday led to the introduction of magneto exploders. According to records obtainable from about the year 1840 onwards the progress of the art alternates between improvements in the apparatus for producing the necessary current, and the means of starting the explosion.

While British and American engineers developed apparatus which depended upon the heating effect of current for its operation, European engineers, chiefly in Austria, sought efficiency in systems of ignition by sparks, from which were evolved the two distinct methods known as high and low tension systems. In the former, the terminal wires are bridged by combustible as well as electro-conductive composition of fairly high electrical resistance. In the low tension exploder-fuse the terminal wires are metallically connected and surrounded by highly combustible mixture.

LETTER TO THE EDITOR.

Micrometer Method of Surveying Water Routes.

Sir,—The article by R. B. Sinclair under the above heading in your issue of February 12th, will bear some elucidation. In the past the micrometer has not been used very extensively and to many surveyors of to-day is practically unknown; consequently, a brief description of the instrument and the principles of operation may not be out of place.

For the micrometer measurement of distance a gradienter attachment on the vertical arc of a transit might be used in conjunction with an ordinary or target levelling rod, but the stadia method is preferable. It is, however, the double-image micrometer that is now under consideration.

There are two types of instruments in use, the Rochon, used by the Dominion Geological Survey, and the Canadian modification of the Luguel, introduced by Jas. Foster, of Toronto, some years ago.

The first consists of a long telescope fitted with thick double refracting prisms. The angular measurement is small and is read on a graduated scale from a pointer sliding longitudinally in a slit in the telescope by a rack and pinion motion. Too much light is absorbed by the prisms in this type of micrometer, and there is a consequent dimness of the images which is the reverse of what is required in a good instrument. The other type of instrument has a split objective, one cut diametrically in halves and each half fixed to a metal frame holding each semi-objective. Motion is communicated by a shaft screw of which one-half is left hand and the other, right. Each part turns in a corresponding nut fixed to the frame thereby moving the objectives in opposite directions.

Targets and Base.—Without expanding on the operation of the instrument as explained by Mr. Sinclair, there are a few important points which he does not touch in his description. When the vernier reads zero objects appear identically the same as if viewed through an ordinary inverting telescope. Two targets attached to a rod will appear as four targets as soon as the split objectives are moved vertically by the screw. This motion

is continued until the two central images coincide, when the angle is read in terms of revolutions of the micrometer screw.

The product of the target base and the micrometer reading is a constant. Thus, after checking a few readings at different distances, a table can be compiled to suit individual requirements. Targets may be attached with screw eyes to any pole cut in the bush—a dry tamarack serves the purpose well—and the longer the target base the better. When the pole is held vertically the lower target should not be closer than 5 or 6 feet from the ground, hence, a pole with base longer than 15 links or 10 feet will be found very inconvenient to handle from a canoe.

The style of target is important. Bevelled rectangular frames fitted with ground glass have been used, but glass is fragile at best. Translucent celluloid answers the purpose better. The frame should be at least 15 x 8 inches. Japanned galvanized iron is better than wood, because the latter will not stand rain. The object in using a translucent target is to allow the sun's rays towards evening to penetrate the marginal frame, otherwise the targets cannot be seen when pointing the telescope towards the sun. The writer has had satisfaction using an enamelled metal disc with one half white and the other half one-third red and two-thirds black. With these targets a long horizontal line can be obtained by slightly rotating the telescope, thus securing perfect superimposition. The object in using the red is to find the targets more readily when snow is on the ground, and particularly at long range.

Results.—A comprehensive paper on the "Micrometer Measurement of Distances," by Wm. Ogilvie, D.L.S., appeared in the 1887 Proceedings of the Association of Provincial Land Surveyors of Ontario (O.L.S. since 1893). Mr. Ogilvie points out that the errors would probably be in the inverse ratio of the lengths of base used, were it not for the fact that atmospheric moisture, density and temperature are varying quantities which constitute the greatest barrier to reasonably uniform results with any form of micrometer.

With a 15-link base and fair atmospheric conditions, distances of 40 chains can be determined within five or six links of error. The error, however, may be ten times that amount on a bad day even though we use our utmost care. Refraction affects the lower disc more than the upper under certain atmospheric conditions. Other hindrances, sometimes impossible to remedy, are improper light and shade and bad background.

By taking shots not exceeding twenty chains equally good results can be obtained for shore line traverses where chaining would be tedious and inconvenient. In very rough country better and quicker results are obtainable if the micrometer is used in preference to the chain.

For exploratory work such as river and lake traverses, the writer has used the micrometer with satisfaction in conjunction with transit, compass and plane table for azimuth or bearing. On a river traverse, where two canoes were used and the entire camp equipment carried along, six miles of traverse per day was the average work accomplished. The river in question was the Wanapitei, a stream full of rapids after turning south, necessitating numerous portages. The courses averaged 8 per mile or 10 chains each, and the error in distance did not exceed two chains across a six-mile township. On larger streams it would be quite possible to traverse ten miles per day.

W. R. ROGERS, Topographer.
Bureau of Mines, Toronto, February 28, 1914.

THE KINEMATOGRAPH AT THE UNIVERSITY OF TORONTO.

By G. R. Anderson,
Associate Professor of Physics.

THE evening of February 6th, witnessed the first public use of the new moving picture installation at the University of Toronto. The occasion was that of a lecture by F. N. Speller, B.A.Sc., Engineer of the National Tube Company, of Pittsburg, on the manufacture of steel tubes and pipes, delivered to the Engineering Society of the University and the Central Railway and Engineering Club of Toronto. The exhibition included all phases of the work, from the mining of the ore to the testing of the finished product, and was unique from an educational point of view, and thoroughly appreciated by the large audience present.

In view of the widespread interest evinced in this method of illustration, a general description of the various parts of the installation may be of interest to readers of *The Canadian Engineer*.

The camera for the taking of films is illustrated in Fig. 1. It consists of a leather-covered body containing the usual film-boxes, each capable of holding 60 metres of film. The lens is an anastigmat of focal length (2 in.)

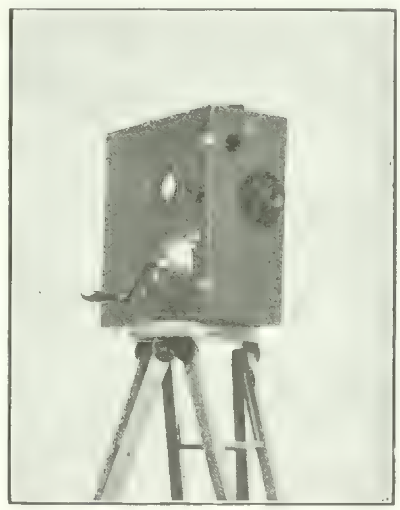

Fig. 1.

and having an aperture of 3.5, thus permitting of exceedingly rapid exposures. The finder is large, and so placed that the field may be observed throughout the exposure. The film is ordinarily driven by a crank, but provision is also made for motor driving when desirable, as will be seen by the triple-step pulley, shown in the illustration. An indicating dial on the side of the camera shows the amount of film being used.

The equipment also includes the apparatus necessary for the animated photography of microscopic objects, such as bacteria, for which purpose the parts are arranged as shown in Fig. 2. The stand is entirely of metal, and sufficiently heavy to be perfectly rigid. The camera is attached to a pair of vertical rods in such a way that by loosening the lever L it may be instantly swung to one side, leaving the microscope in position for eye observation, and as quickly returned to place. The lens of the camera is removed and connection with the microscope established by means of a small leather bellows, while an adjustable lens inserted in the side of the camera permits the observer to watch the microscopic field at the same time that the photographs are

being taken. The film in the case of microscopic work is preferably driven by a motor operating against a worm gear, whence the motion is transferred by a belt to the camera. The motor is controlled by a foot-switch, so that the operator has both hands free to take care of the adjustments of the microscope and lamp. The light for the illumination of the microscopic field is furnished by a small arc lamp, the light from which passes through

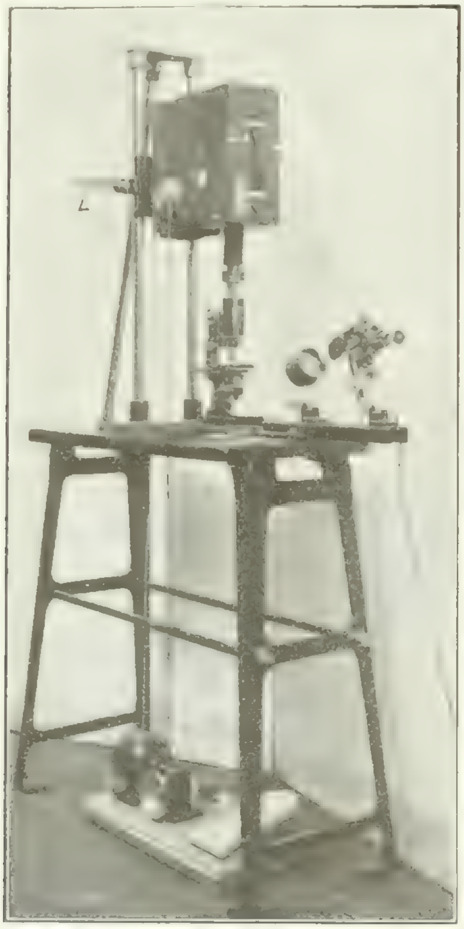

Fig. 2.

a condenser and a liquid cell to absorb the heat and, if necessary, the violet and ultra-violet rays. All these accessories move on a planed optical bed and are readily adjustable to suit requirements.

The microscope is a Zeiss of the large barrel type, specially designed for photo-micrography. It has a photo-micrographic stage, adjustable by rack and pinion in two directions, its position being indicated by verniers reading to 1/10 mm., and furnished with an achromatic substage condenser, which can be instantly swung out if not required. The optical equipment consists of 4 apochromatic objectives and 6 compensating oculars, giving magnifications ranging from 31 to 2,250. Provision is also made for using polarized light if required.

The projector (Fig. 3) for exhibiting the finished films is of particularly substantial construction to insure steadiness and rigidity. The stand is of metal, and has a tilting top with a range of about 17°, permitting of both elevation and depression. The lamp-house is constructed of sheet iron lined with asbestos, ventilated by means of a rising roof provided with a wire guard and closed at the rear by an asbestos curtain. The lamp is of the right angle type, provided with adjustments for tilting, raising and side-swinging the arc. The condenser is open-mouthed, of hard water white glass, and can be instantly lifted out of its bearings. The film fire-guard, G, is a distinctive feature of this projector. It is of two-ply steel, enclosing an interlining of asbestos, and extends from the upper magazine wall above the film exit to the base, so that there is no possibility of the film coming into contact with the lamp. The magazines are large and of very solid construction, consisting of spun steel without joints and lined with asbestos; the doors are securely locked, so that it is not possible for them to become unfastened accidentally. The film emerges from the upper magazine through a film-way of metal, closed by a clasp, and which is so narrow that in the event of the film taking fire the flame cannot pass up through this throat and set fire to the reel; the same construction is, of course, followed at the lower magazine. The winding of the film on to the lower spool is effected by a metal driving-rod geared to the main shaft. This is much more reliable in its action than the usual belt drive. Fig. 4 shows the left side of the machine with the cover of the Geneva movement removed. The special features of this

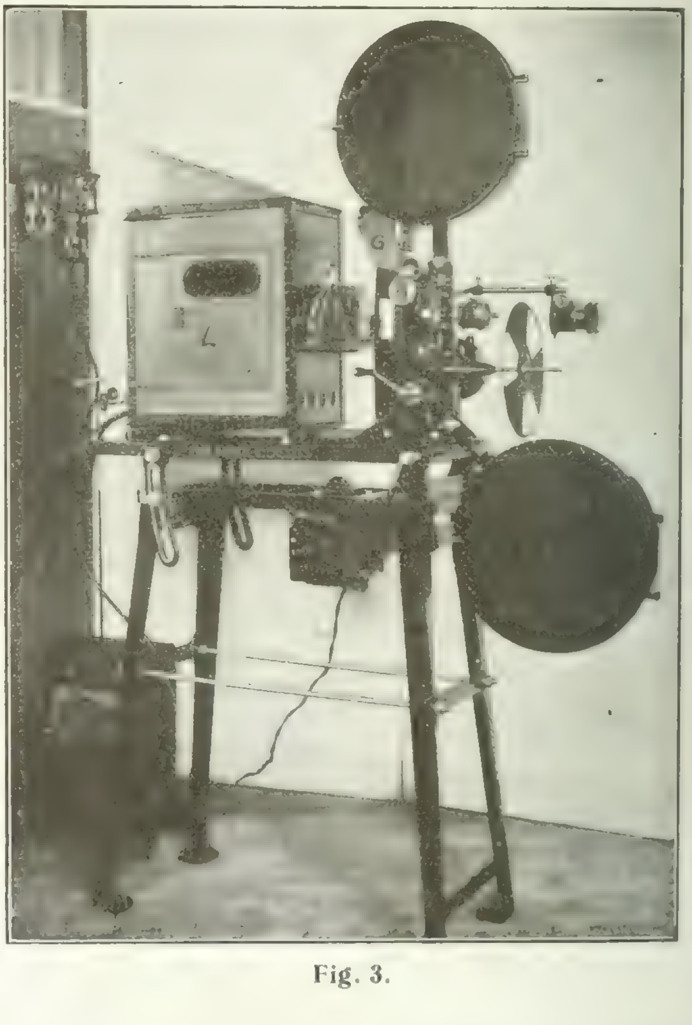

Fig. 3.

vital part of the mechanism are the extra large Maltese Cross and the roller bearing for it to operate on (ordinarily this roller is merely a pin); this eliminates friction, noise and wear of the parts; further, the whole movement is enclosed in an oil bath.

The machine is driven by a motor bolted to the framework and provided with a speed regulator, so that absolute steadiness of the film is secured over a wide range of speeds. The lamp-house slides on two planed rails, so that it can instantly be pushed over to the end

for the purpose of showing ordinary slides. These are inserted in a double carrier attached to the frame on which the condenser rests, and one slide may always be left in place while the film is being shown. There are two projection lenses of large aperture and flat field, one for the projection of the film and the other for the slides, the focal length of the former being 5 inches and of the latter 15 inches, so that the images from film and slide are of equal size. The adjustment of the mask to fit the film is accomplished by a rack and pinion movement operated by a large milled head, shown at A, Fig. 3. This permits

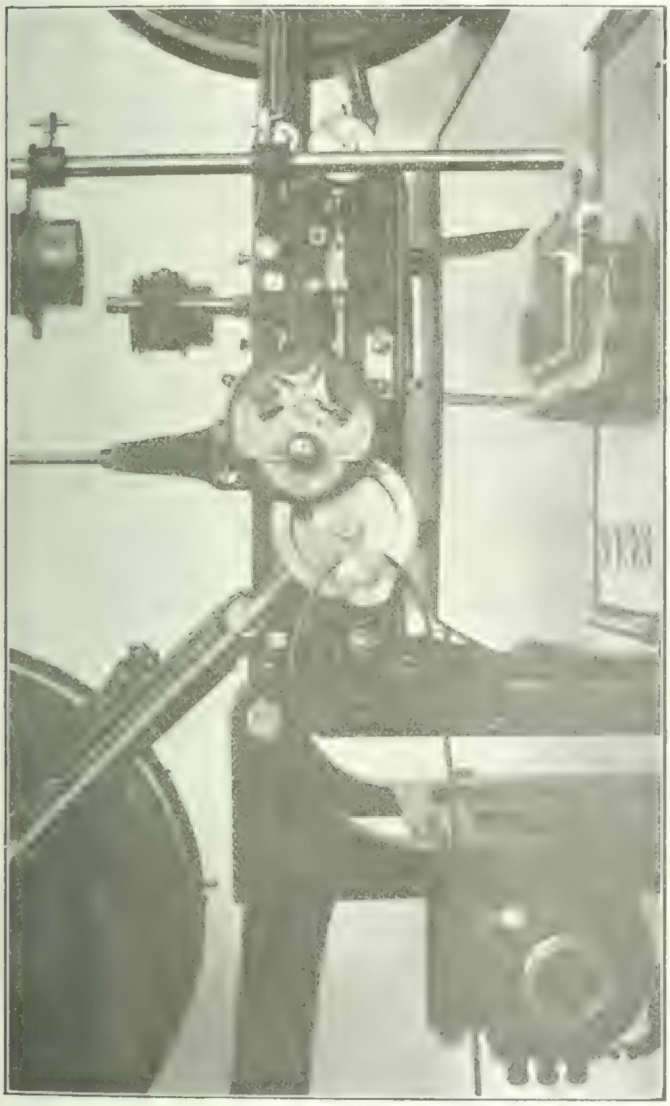

Fig. 4.

of the film being correctly placed without interfering with the position of the projecting lens or the mask, an exceedingly convenient arrangement in practice. The workmanship throughout the entire installation is of excellent quality, the gears are carefully cut, and the machine runs lightly and steadily with a minimum of noise.

A recent publication at Sydney, N.S., announces that the output at the several collieries of the Dominion Coal Company for the month of January was 347,000 tons. This is about 38,000 tons less than the output for January, 1913. The company's officials anticipate an increased output for this month, however, and it is believed the total will run over 400,000.

REPORT ON OTTAWA RIVER AS SOURCE OF SUPPLY FOR CITY OF OTTAWA.

On March 9th the City of Ottawa will take a plebiscite vote to ascertain the will of the citizens in the choice of water supply. The difficulties which the city has experienced in coming to a decision in this matter has been frequently commented upon in this journal. A new report has been submitted to the city council covering the latest scheme to be included in the vote next Monday. Mr. Arch. Currie, City Engineer, was requested by resolution of council a month ago to prepare a report on a proposal to derive the supply from the Ottawa River from a point not higher up than Britannia Bay on Lake Deschenes by an all-land pipe line route on the Ontario side of the river, to the present pumping station, the system to include a low-service reservoir and a rapid sand filtration plant.

The other four schemes are: The Thirty-One Mile and Pemichangaw Lakes, as reported upon by Sir Alexander R. Binnie and Dr. A. C. Houston; McGregor Lake, as reported on by Mr. Allen Hazen and others; mechanical filtration of the Ottawa River water, as reported upon by Mr. Allen Hazen; Lake Deschenes, without filtration, as reported upon by Arch. Currie, City Engineer.

Mr. Currie was instructed to report upon the feasibility of a plan to take the Ottawa River water from a point above the present intake and purify it by means of a modern rapid sand purification plant; to estimate the capital cost of providing such a purified supply, based on an average daily use of 25,000,000 Imperial gallons per day; to estimate the annual operating costs and fixed charges for pumping and purifying a supply of 25,000,000 gallons per day; and to estimate also the additional annual operating costs and fixed charges which would be incurred over and above present conditions.

The report states that in the vicinity of Ottawa the Ottawa River has a minimum flow known to be many times greater than the requirements of the city for a public water supply. The quantity available for this purpose may therefore be considered as unlimited.

The water of the river is colored yellow or brown by organic matter. It is a soft water having a slight odor and taste. The turbidity varies from month to month but for most of the year is not serious. It is also somewhat polluted, especially below the Chaudiere Rapids and Lemieux Island. Above these points the pollution is and always will be much less, and as far as natural rivers are concerned it is one of unusual purity for public water supply.

Mr. Currie refers then to a special study which he has made of the available data on the purification of waters similar to that of the Ottawa.

During his regime as city engineer of Westmount, the Montreal Water and Power Company installed a purification plant which has been in successful operation for the past few years. This plant supplies a colorless, purified water of excellent quality and at the rate of 25,000,000 gallons per day to the customers of the company, among whom are the citizens of Westmount. The water purified by this plant is, during a considerable part of each year, almost identical in character and quality with that of the Ottawa River at Ottawa, and is, in fact, almost entirely Ottawa River water.

The plant upon which Mr. Currie has estimated is of similar character and has operating conditions very like the plant at Montreal.

There are other purification processes which could be used for the water of the Ottawa River, but none of them are, for various reasons, so well suited to the local conditions as the type mentioned. In order to avoid the large amount of pollution in Nepean Bay and the necessity of delivering purified water under this portion of the Ottawa River if the purification plant be placed on Lemieux Island, the report recommends that the intake be placed at some point above the Little Chaudiere Rapids, with the purification plant on the mainland, and estimates were made accordingly.

General Description of Proposed Works.—The intake pipes, two in number, extend out into the river between the Little Chaudiere Rapids and Remic's Rapids. This point of intake reaches a part of the river where the conditions are favorable for minimum pollution. The water passing through the natural sedimentation basin of Lake Deschenes is partly purified by nature during this process and the point of intake has been selected with the object of taking full advantage of this fact. When the Georgian Bay Canal will have been built the purification due to this natural sedimentation basin will be even better owing to the larger area of lake created by the building of the canal works.

On the shore near the end of the intake pipe is situated the pumping station. This should contain electrically driven, low-lift turbine pumps of sufficient capacity to supply the purification plant at its maximum rate of working with provision for some spare machinery in case of breakdown. The low-lift pumps at present in use at Lemieux Island may perhaps be found suitable for part of the equipment after some modifications, in which case the estimated capital costs could be reduced accordingly. The electric current for the regular operation of these pumps could best be derived from hydro-electric units installed in the main pumping station.

When the Georgian Bay Canal will have been built it will be necessary to remove the pumping station from its first location to one above the elevation of the new water surface. This is not a serious matter and involves no special difficulty or great cost. The proposed location for the pumping station under these conditions is indicated on the plan. Under these future conditions the power required at this station will be reduced appreciably.

The transmission lines from the main pumping station to the headworks pumping station may well be carried on cedar poles treated to prevent decay. They should consist of 3-phase circuits in duplicate at a suitable voltage.

The estimates are based upon the use of steel pipes from the headworks pumping station to the purification plant and reservoir, and thence to the main pumping station. The quantity of water required under maximum conditions is such that an effective cross-sectional area of about 19 sq. ft. is desirable in the pipe line in order to provide for this quantity with some capacity for future growth. The smallest single pipe which should be used for this purpose is one of 60 in. in diam. My estimates are based upon using two pipes each 42 in. in diam., having an area equivalent to that of the 60-in. pipe, but giving a greater flexibility in operation and a good insurance against breakdown. The two 42-in. pipes will cost somewhat more than a single 60-in. pipe, but the extra expenditure is justified by the advantages gained. Cross-connections at intervals are provided for from one 42-in. pipe to the other, thus insuring flexibility in operation. In case of trouble occurring in either pipe line, or in case inspection or repairs be required, it will be necessary to shut down only a comparatively short length of

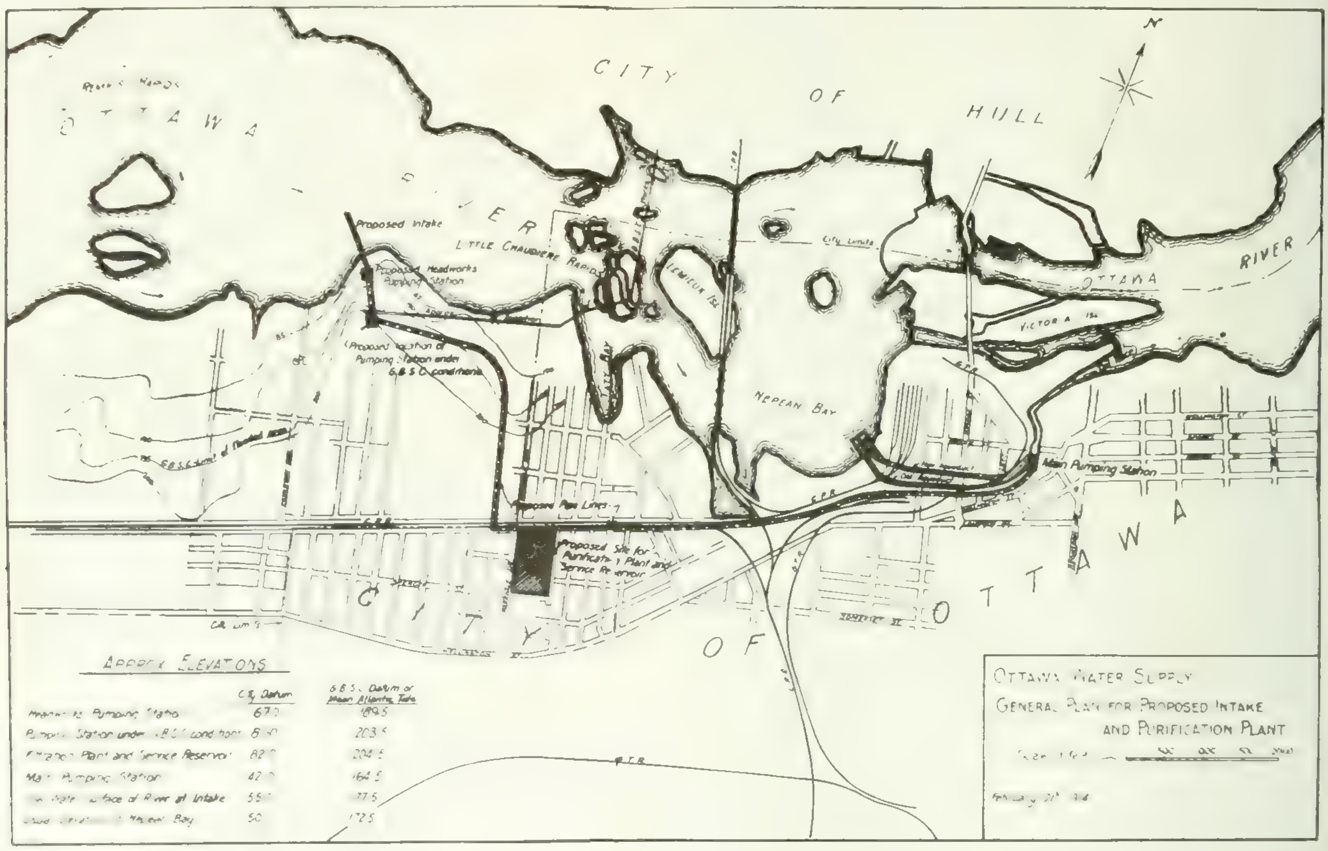

Fig. 1.

one pipe at a time, a proceeding which will effect the gross capacity of the pipes by only a small percentage.

Purification Plant and Reservoir.—The purification plant should consist of comparatively large sedimentation and coagulation basins designed with baffle walls to cause the water to flow slowly enough through the basins so that a large part of the impurities will be deposited in them. From the coagulation basins the water should flow by gravity to the filter beds and down through the sand in these to the clear water reservoir beneath. The coagulation basins, filter plant and clear water reservoir should all be covered on account of our climatic conditions and to prevent local pollution. Such additional machinery and appliances as are necessary in and about the purification plant require very little space and are simple in character. Two or three men per shift operate such a plant without difficulty.

The average daily output of water, 25,000,000 gallons, is much less than the nominal capacity of the plant estimated upon. The proposed plant can filter satisfactorily over 35,000,000 gallons per day and many of the parts have been so proportioned that the capacity of the plant may be considerably increased at a comparatively small expense either for capital cost or yearly operating charges.

The clear water reservoir has been designed to hold 10,000,000 gallons of filtered water, which is ample to provide for very heavy fire requirements in addition to the maximum draft under ordinary conditions of use.

Main Pumping Station.—Certain work is necessary at the main pumping station on Queen Street in order to develop the best efficiency. While it is possible to use all of the present pumping equipment for some time to come, the report advises discarding some of the present pumps and substituting for them modern machines of a different type and of sufficient capacity to serve all needs with ample spare units. If this be done, the present building is sufficiently large for the installation of several new pumping units. A certain amount of work is necessary in the headrace and some remodelling of the wheelpit and tailrace is essential. Certain new drains and a proper spillway should also be constructed. The draft tube arrangements must also be modernized. Where the pure water comes into the pumping station provision should be made for a standpipe and a header or for a common suction well so that all the pumps may obtain a sufficient supply of water, which they do not get at present. On the delivery side of the pumps a common discharge header should also be installed so that any part of the distribution system of the city may receive water from any of the pumps.

Two hydro-electric units should be installed of sufficient capacity to generate current to be transmitted to the headworks pumping station and to the purification plant for the operation of the pumps at these places. There is sufficient hydraulic power available at this pumping station site for this use with a good allowance for future extensions beyond the daily average use of 25,000,000 gallons.

In the time allotted for the preparation of the report it was impossible to determine the best course to adopt in connection with the main pumping station. The above discussion is only indicative of one general programme which would be highly advantageous compared to the present state of the old plant.

The distribution system is not dealt with in the report as it has already been covered in a previous one.

Estimated Capital Costs.

1.—Intakes, cribs, two suction pipes each 54 in. x 850 ft. complete ....$	67,000
2.—Headworks pumping station, pumps and equipment, electrical apparatus and transmission lines from main pumping station..	54,000
3.—Costs of moving station and equipment to suit new elevation of Georgian Bay Canal, with new connection	25,000
4.—Two 54-in. pipe lines, as far as future pump house site with reducing and cross-connections, complete, 650 ft. each, in one trench and suitable for future suction conditions	43,000
5.—Two 42-in. pipe lines from pump house to purification plant, and thence to main pumping station, 11,300 ft. of double line in one trench, making 22,600 ft. of pipe, with valves, cross-connections and so forth, complete	356,000
6.—Real estate and right-of-way, headworks pumping station sites, reservoir and filter plant site at 10c. per sq. ft. and $10,000 for right-of-way, say	45,000
7.—Purification plant, nominal capacity 37,000,000 gallons per day, and based on average daily use of 25,000,000 gallons per day with large coagulating basins and 10,000,000-gallon clear water reservoir, complete	705,000
8.—Remodelling present pumping station, replacing units 1, 2, 3 and 4 with four 10-million-gallon turbine pump units connected to new power turbines, changes in headrace, tailrace, wheelpit and draft tubes, new suction arrangements with tank, new delivery header, two hydro-electric generating units	159,000
	$1,454,000
Add for engineering, contingencies and miscellaneous costs, say ....$	246,000
Total..........................$	1,700,000

Annual Operating Costs and Fixed Charges.—The annual operating costs and fixed charges of the system outlined include everything down to the beginning of the distribution system. The annual costs have been estimated on the same conservative basis as the capital costs. The number of men allowed for is sufficient for any contingency and will probably be less in actual practice.

The treatment necessary for the Ottawa River water requires the use of sulphate of alumina and carbonate of calcium with a final treatment with a minute quantity of sodium hypochlorite if found necessary. The amount varies from month to month, depending on the changing character of the water, but the figures given in the table below are more than sufficient to treat any condition of the Ottawa River. For protracted periods it will be unnecessary to use a final treatment. A liberal amount has been added for the item of maintenance and repairs, while oil, waste, fuel, packing, small tools and other supplies have also been provided for in the same generous degree. The charge for power should be very small. The costs of power generated in the pumping station will only be the fixed charges on the machinery equipment itself, as the labor, supplies, repairs and so forth

of the electrical equipment are included with the figures for the pumps. To provide for interest and sinking on the total capital invested, a figure of 6½ per cent. has been assumed, which should be more than ample.

Estimated Annual Operating Costs and Fixed Charges.

Wages and Salaries—	
Intake pumping station (3 operators and 3 assistant operators)	$ 5,500
Reservoir and filter plant (1 chief chemist and superintendent, 1 assistant superintendent, 3 operators, 3 assistant operators, 1 spare man)	10,000
Main pumping plant remodelled (3 assistant engineers, 3 operators, 3 assistant operators, 3 winter men, 1 spare man)	11,500
General (1 patrolman inspector, emergency help and proportion of time of waterworks engineer, say)	3,000
	$ 30,000
Supplies—	
Oil, waste, fuel, packing, small tools, and chemicals for headworks, station, purification plant and main pumping station	43,000
Repairs and Maintenance—	
Intake, pipe lines, filters and reservoirs, main pumping station, aqueduct, transmission lines, headworks pumping station and miscellaneous	16,000
Power—	
Main power service is included in operation and fixed charges	
Fixed Charges—	
Interest and sinking fund, say, 6½ per cent. on whole amount of $1,700,000...........	110,500
Total..............................	$199,500

The report concludes with the following summary: For the City of Ottawa the intake would best be placed between Remic's rapids and the Little Chaudiere Rapids. The general plan considered to be best suited consists of an overland steel pressure pipe line from the intake to a purification plant situated at the intersection of Scott Street and Parkdale Avenue. From the purification plant the pure water will collect in a service reservoir at the same site, whence it will flow in a steel gravity pipe line to the present main pumping station remodelled. The requisite power will be obtained from the present aqueduct. The system outlined above can be constructed and put in operation within two years.

The estimated capital cost of the above plant based on the average daily use of 25,000,000 gallons is $1,700,000.

The annual operating costs and fixed charges on the same basis will not exceed $200,000.

The additional annual operating costs and fixed charges which would be incurred over and above present conditions would not exceed $145,000.

After 9 years of labor the last barrier was broken on January 10th in the Catskill Aqueduct tube, the longest water tunnel in the world. It extends 111 miles, from the Ashokan dam at Esopus, N.Y., to Brooklyn; and when in operation, will supply New York with 500,000,000 gallons of water daily. The tube for the most part is 500 feet beneath the ground, and in spots dips to more than 700. It varies in diameter from 11 to 17 feet.

ONTARIO GOOD ROADS ASSOCIATION.

The twelfth annual meeting of the association was held in Toronto on February 24, 25 and 26th. Several hundred delegates, were in attendance from all parts of the province. The papers and discussions were, in the main, upon subjects bearing upon administration and financing, although a few dealt with engineering aspects of road work. Among the latter were "City and Town Streets," by A. B. Macallum, City Engineer, Hamilton; "Bridge Construction," by L. E. Allen, Belleville, Engineer, Hastings County, and others. C. A. Macgrath, Ottawa, chairman, Ontario Highway Commission, gave an address during one of the sessions on the work of the Commission.

MODERN CONCRETE CONSTRUCTION.

Some very interesting concrete work has just been completed by the American Cyanamid Company of Niagara Falls, Ont. The construction was started last October of a Silo Building, 90 feet high, having 184 corners to its 16 columns. The columns are connected by 16 very large triangular lintels, which are heavily reinforced. They support nine 18 x 18 feet bins, 50 feet high, each have a suspended concrete hopper.

These bins carry a weight of ten thousand tons of cyanamid. The entire building, from foundation to roof, was built with the Blayney system of steel forms, manufactured by the Standardized Steel Form Company, Niagara Falls, Ont. With a slight change, the column forms were used as wall forms right to the roof.

1914 WORK IN MEDICINE HAT.

The following work is contemplated for the coming season in Medicine Hat, Alta.:—

Surface and stearm sewers	$ 60,000
Extending and improving waterworks	175,000
Parks and other municipal purposes	14,000
Extending and improving electric plant, light system and power system	150,000
Extending gas system and drilling gas wells	50,000
Grading and gravelling streets and purchase of road construction plant and machinery.........	50,000

A paper was presented by G. E. Lygo before the Junior Institution of Engineers in England, showing that plants in which all kinds of wood waste, from sawdust to pieces 6 inches in diameter, as well as cotton seeds, cocoanut shells, coffee husks and many other kinds of refuse, can be used for the manufacture of producer gas are now being manufactured in England. In designing a plant for this purpose many changes must be made from the coal producer. The surface area required is determined by the nature of the fuel used and its size, but will average 2.5 times that required with coal. The depth of the fuel bed will depend upon the size and density of the fuel. A deep bed is necessary where the pieces are large; whereas a shallow bed is preferable with small fuel like sawdust. A vaporizer is not required. The gas must be cooled and washed immediately upon leaving the generator or else the heavy tar in suspension is deposited and will choke the piping. The calorific value of wood when air-dried is approximately 6,000 British thermal units per pound. The amount consumed in generating a horsepower-hour depends upon the moisture, which varies from 10 to 20 per cent. in air-dried wood to 30 or 50 per cent. in fresh wood. Fuel containing an excess of moisture must be dried until it is reduced at least to 60 per cent.

MONTREAL WATER SUPPLY CONDUIT

REPORT OF THE BOARD OF EXAMINERS OUTLINING DEVELOPMENT OF CITY'S WATER SUPPLY AQUEDUCT, CONDITION OF THE CONCRETE CONDUIT, GENERAL CONCLUSIONS AND RECOMMENDATIONS.

THE following is from the report to the Board of Commissioners of the City of Montreal covering the result of the investigation of Messrs. J. A. Jamieson, R. S. Lea, and G. R. Heckle, Board of Engineers, as to the cause of the accident to the city waterworks conduit*; the measures necessary to provide, as far as possible, against any further damage; and the condition of the entire conduit as shown by inspection of its interior, and the exterior condition of the aqueduct bank adjacent to and overlying it:—

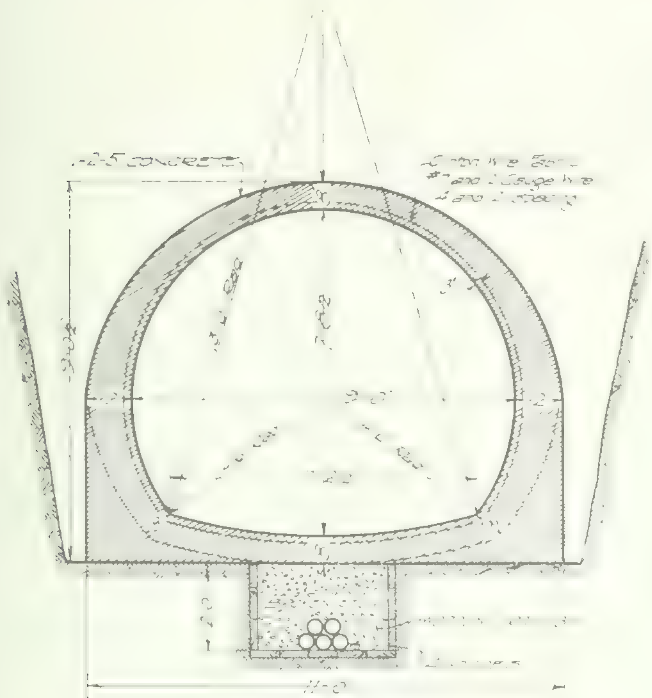

Fig. 1.—Cross-Section of the Conduit.

Description of the Water Supply System.—As the question of the conduit is intimately associated with the enlargement of the aqueduct, a brief history of the more important events in connection with the city's water supply is necessary to give a more complete understanding of the subject.

*See *The Canadian Engineer*, January 8th, 1914, Page 151.

The City of Montreal has, for many years, obtained its water supply from the St. Lawrence River through an open canal, or aqueduct, as it is locally known, extending from a point some distance above the Lachine Rapids, and running in a northeasterly direction nearly parallel to, but a considerable distance from, the river to the pumping station located at the junction of Centre Street and Atwater Avenue.

For a number of years following its construction, this aqueduct supplied water for city consumption, and also furnished hydraulic power for pumping the water into the city mains and reservoirs. As the population and water consumption increased, the hydraulic power became inadequate, and a supplementary steam pumping plant was installed. Eventually the hydraulic power available from the aqueduct represented such a small proportion of the total requirements for pumping purposes as to be almost negligible.

The question of enlarging the aqueduct to a size sufficient to supply power for pumping the total quantity of water required for city consumption had been investigated and reported upon by various engineers from time to time, and in 1907, based on a report submitted by Mr. Geo. Janin, Chief Engineer of Public Works of the City of Montreal, it was decided by the authorities to proceed with the enlargement referred to above.

The conduit which failed on December 25th, 1913, was built to protect the city water supply against surface pollution between the river and the pumping station, and also to provide continuous service while the aqueduct was being enlarged, during which period it constituted the only source of supply.

This conduit extends from the St. Lawrence River to the pumping station, and is located in a trench along the north bank of the aqueduct. The water flows through it by gravity under a head varying from six to twelve feet. It is constructed of concrete lightly reinforced with Clinton wire fabric. The plans and specifications were prepared under the direction of Mr. Janin. Fig. 1 shows the cross-sectional plan. The contract for its construction was awarded to Mr. P. McGovern, under date of October 3rd, 1907, and the work was completed about two years later.

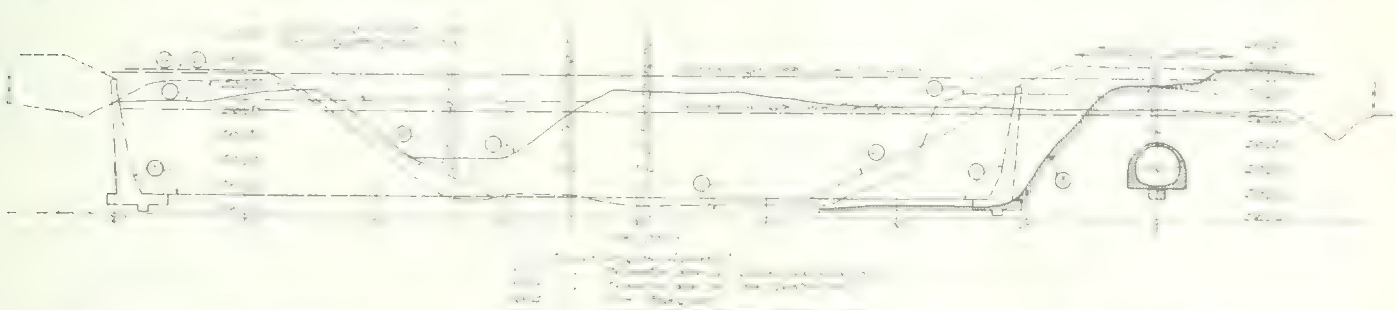

Fig. 2.—Section Showing Relative Size of Old Aqueduct, Enlargements 1 and 2, and Location of the Conduit.

On October 12th, 1909, a contract for the enlargement of the aqueduct was awarded to Messrs. Quinlan and Robertson. This is now known as Enlargement 1. The enlarged section was estimated to carry sufficient water to produce 2,500 h.p. during the winter months, with a probable 5,000 h.p. during the summer, to be used for pumping the city's water supply.

Before the work covered by the above contract was entirely completed, it was decided by the city authorities to still further enlarge the aqueduct in order to obtain sufficient power to generate electric current for lighting purposes in addition to pumping the city water. This is now known as Enlargement 2, for which the plans and specifications were also prepared under the direction of Mr. Janin. Fig. 2 shows the relative size of the old aqueduct, enlargements 1 and 2, and the location of the conduit.

To obtain the necessary cross-sectional area of aqueduct, and, at the same time, to keep as nearly as possible within the limits of the property owned by the city, the plans for Enlargement 2 required the excavation to be carried much closer to the conduit than under contract 1.

The contract for Enlargement 2 was awarded by the city to the Cook Construction Company, under date of July 17th, 1913. This company, in carrying out the work under their contract, employed drag-line excavators for the earth excavation. These machines, which weigh 120 tons each, operate from the top of the banks, moving along on skids and rollers, and perform their work by swinging 3-cu.-yd. drag-buckets into the excavation by means of cables and boom. This drag-line bucket is then drawn towards the machine by a cable and digs into the earth as it is hauled up the slope, depositing the excavated material on the bank. The location and operation of this heavy machine (See Fig. 3) over the conduit imposed a heavy live load on it concurrently with the removal of its lateral support on the aqueduct side. The effect of this was to cause a readjustment and sliding of the bank which tended to produce excessive stresses in the conduit.

During December, one of these machines was working eastwards along the north bank over the conduit, and between Sta. 119 and 129 the excavation was carried so close to the conduit that an earth slide partially exposed its side between Sta. 123 and 124, about 100 ft. east of the Asylum bridge. Inspection showed that considerable water was leaking from the conduit at this point through cracks in its side, and attempts were made to stop the leaks and support the conduit, but without success. At about 4.30 p.m. December 25th, the side of the conduit burst out for a length of about 60 feet, as shown in Fig. 3.

As this break in the conduit entirely cut off the city's water supply, emergency repairs were planned by Messrs. Janin and Lesage, and the Cook Construction Company's plant and organization were called upon to execute the work. These repairs were made and the water again let into the conduit on January 2nd. Since then the supply has not been interrupted.

Fig. 3.—Montreal Waterworks Conduit Break as it Appeared on December 27th, 1913. (Drag line excavator has been moved up from point of operation at extreme right of photo, to be used in excavating the earth around the break).

Examination of the Conduit.—On December 28th, Mr. J. A. Jamieson was retained as consulting engineer, and during the following 48 hours made an inspection of the interior of the conduit, accompanied by Messrs. Janin and Lesage. On December 30th, Messrs. R. S. Lea and G. R. Heckle were retained, on which date they, accompanied by Messrs. McKillop and Ommaney, Canadian Pacific Railway engineers, inspected the interior of the conduit.

The condition of the conduit as disclosed by this inspection was as follows:—

The concrete was found to be of good quality and workmanship throughout the entire length. The conduit from the intake end at river, Sta. 270 + 50 to Sta. 220, was found to be practically free from cracks or other defects. Along this part of the conduit the depth of the overlying earth is only 6 to 8 ft.

At about Sta. 220, there is a coffer-dam built across the aqueduct. From this point to the river the water stands in the aqueduct at the river level, while from the cofferdam eastward to the pumping station, the aqueduct has been unwatered to permit the enlargement to proceed.

Between Sta. 220 and 214, a distance of 600 ft., a serious crack was found in the crown of the arch. This crack was about ⅜-in. in width, and in places the roof on one side has sunk down about ⅜-in. further than on the other. There are also corresponding cracks in the invert, and signs of strain along the springing line on both sides. These cracks clearly indicate a distortion of the conduit from an overlying load.

An inspection of the interior disclosed the fact that along the cracked section excavated material had been dumped directly over the conduit up to about El. 58, making the overload about 25 ft. above the crown, plainly accounting for the cracked and distorted conditions found. The east end of the cracked section corresponds with the point where the conduit passes from earth into rock.

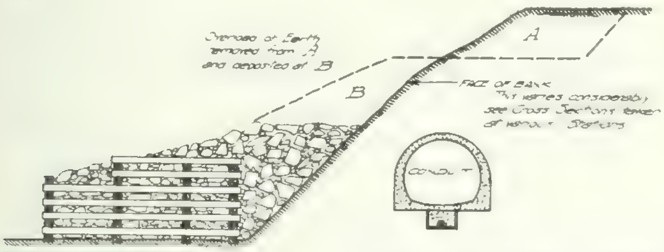

Fig. 4.—Method Adopted to Support Bank and Conduit.

A subsequent inspection along the aqueduct bank showed a very considerable leakage of water from the conduit along the cracked section between Sta. 220 and 214. For the most part, this water finds its way into the aqueduct through gravel strata, and shows no signs of transporting any of the clay material; and the conduit is located at this point approximately 40 ft. back from the aqueduct bank.

Between Sta. 214 and 133, the conduit is located partially or wholly in rock, and was found to be generally in good condition.

Between Sta. 133 and 120, there are cracks along the crown, both sides, at about the springing line of the arch, and in the bottom, but as a rule these are not open to any extent. They indicate considerable stress, however, and some distortion in the conduit. It is in this section, between Sta. 123 and 124, that the break occurred, and an inspection made after the conduit was filled with water disclosed the fact that, at several points along the bank, water was leaking from the conduit and finding its way into the aqueduct.

Between Sta. 69 and 120, there is a light crack along the crown for a considerable part of the distance, but for the most part this crack is comparatively small. An apparent leak has been found in this section near Sta. 94, but the water was running out through gravel strata and was quite clear, indicating that the leakage is probably not endangering the conduit at this point.

Between Sta. 69 and 50, the conduit is cracked along the crown and in the invert, these cracks being open for the most part about ⅛ in., and by cutting into the concrete at certain points it was found that the reinforcing wires were broken in the crown. There are also some cracks at about the springing line of the arch. Along this section it was found that the original fill over the conduit was only 5 ft., but that during the operations under the Quinlan and Robertson contract, excavated material from the aqueduct had been deposited along the bank over the conduit up to approximately El. 45, making the fill about 15 ft. higher than the top of the conduit. This fill, however, is not generally over the centre of the conduit, but south of it, thus producing an unbalanced load. A close examination would indicate that these cracks were not of recent date.

Between Sta. 50 and about 30, the conduit was in good condition, showing no evidence of anything beyond occasional fine cracks. It was impossible to proceed further east with the inspection on account of the depth of water.

An inspection was made of the existing head gates at the entrance of the aqueduct, and where the section has not been disturbed by either Contracts 1 or 2. It was found that the aqueduct had been provided with both head gates at the entrance from the river and regulating gates further down, but that in both cases the gates were in very bad repair, and entirely useless at the present time.

As there should be a means available at all times for controlling the flow of water in the aqueduct, it is urged that the Cook Construction Company proceed at once with the construction of the coffer-dam at the entrance as covered by their contract, also that the necessary gates and sluices for controlling the flow be included in the structure.

Recommendations After First Inspection.—On the night of December 30th, after completing the above inspection of the interior of the conduit, the Board of Engineers met Controller Godfrey, Messrs. Janin and Lesage, and Mr. Herlihy, of the Cook Construction Company, at the city's office near the break, and verbally made certain recommendations, as follows:

1. That rip-rap be placed against the toe of the slope along the weakened sections in the vicinity of the break as rapidly as possible.

2. That, when the water was turned into the conduit, it should not be allowed to run more than ¾ full, and kept below that depth if possible.

3. That the overload of earth be removed from the top of the conduit for a considerable distance east and west of the break.

4. That the overload on the section lying approximately between Sta. 214 and 220 be also removed as soon as possible.

5. That the excavation work on the north side of the aqueduct be suspended, and that for the present no blasting be allowed in the rock section on the north side.

These verbal recommendations were confirmed and further emphasized in a written report addressed to the Board of Commissioners under date of January 7th, in which certain other additional recommendations were made, including the construction of a rock-filled timber crib along the toe of the bank at the weakened section both east and west of the break, to support a fill in an endeavor to reproduce the original conditions of loading.

In accordance with the recommendations of the interim report, an arrangement was made by the Board with the Cook Construction Company to proceed immediately with the carrying out of the work involved. The most important measure, namely, placing rip-rap along the toe of the slope at the weakened section on both sides of the break, between Sta. 119 and 129, to be followed at once with the construction of a rock-filled crib, was proceeded with first, night and day shifts being employed. Mr. J. R. Dorrance was placed in charge of the work by the city, as resident engineer, and Mr. F. S.

Pearson, as superintendent. While the above-mentioned work was being carried out, the very difficult matter of securing the conduit at both ends of the steel pipe at the break was being done. This work required the utmost care as it was found that cavities had been eroded on both sides of the conduit and directly underneath by leakage, which, of course, made the situation a very serious one. Blocks of concrete were placed in sections underneath the conduit where the foundation was scoured out, and the leaks in the side were caulked and afterwards encased in concrete. The water draining through the conduit in both directions towards the break and at other points on both sides was carried in troughs to the aqueduct, so that no further scouring would occur.

Fig. 4 shows a cross-section through the rock-filled crib, and the conduit, and gives a general idea of this work.

When the protection work adjacent to the break was well under way, a force was started removing the excessive load from the top of the conduit between Sta. 214 and 220, a wedge-shaped section being taken off to El. 47, approximately, thus removing about half the load over the crown. It was considered advisable to do this work entirely by hand labor, on account of the danger of using machinery adjacent to this cracked section.

At this time it was thought advisable by the Board, and with the approval of Mr. John R. Freeman, to lay a pipe connecting the Lachine canal with the present pump-well; this work being at once proceeded with. This precaution was justified by the possibility of another break in the conduit which might expose the city to the danger of a conflagration. It should not interfere in any way, however, with measures being taken as soon as possible for furnishing the city with an alternative supply of pure water, and that water from the Lachine canal should not be turned into the city mains except as a last resport.

Details of Design and Construction of Conduit.—Fig. 1 shows a cross-section of the conduit used in soft soil. The dotted line below the springing line of the arch shows the form used in firm soil or rock. In both the latter cases, the reinforcement was to be omitted below a point 12 in. below the springing line. In firm soil, the earth was to be excavated to the neat line of the bottom and the side walls. In rock, any excess excavation was to be filled with lean concrete composed of 1, cement; 3, sand; 8, 3-in. broken stone.

Article 18 of the specifications covers the character and location of the reinforcement. It reads as follows:

> The reinforcing material of the conduit shall consist of expanded steel No. 6 with 6-in. mesh; or of other reinforcing metal which shall be known to have an equal degree of resistance. In the case of tenderers wishing to substitute a different material than No. 6 expanded steel with 6-in. mesh, they will have to clearly specify the nature and weight of the reinforcing material they propose to make use of. The reinforcing metal shall be set at about 3 in. from the interior surface of the conduit, and each sheet of metal shall be lapped over the adjoining one, to the width of one mesh to form a continuity of joints, but only in the crown of the conduit shall the adjoining sheets of metal be attached together with wire.

As will be noted in Fig. 1, Clinton wire cloth was substituted for the expanded metal specified.

With regard to the design of the conduit. From the information which we have obtained from the city, the maximum depth of fill over the crown would be approximately 25 ft. Engineering practice in concrete conduit design exhibits a considerable variation in the sections of concrete and the percentage of reinforcement used. While there are examples of as light, or possibly lighter, types of similar structures in existence, we consider the concrete sections employed in the Montreal conduit are lighter than are warranted by safe engineering practice. We feel, moreover, that the percentage of steel used and the position in which it is placed does not constitute an adequate reinforcement against the stresses to which the structure is subjected. The above statements are particularly pertinent having regard to the fact that this conduit represented the only water supply line to the city.

The weight per sq. ft. of the reinforcement called for in the specifications is not stated therein, and as expanded steel of this particular class is not now commonly manufactured, we have not been able to definitely compare the relative weights of the steel fabric specified with that actually used. So far as our information goes, however, it appears to us that the reinforcement does not represent an adequate equivalent for the expanded steel referred to in Art. 18.

So far as our inspection of the conduit enables us to report on the matter, we consider that the concrete is of good quality and that in general the work has been well executed.

The soil through which the aqueduct is being excavated and in which the conduit is embedded for the greater part of its length, is largely composed of boulder clay or rock powder. When comparatively dry, or well drained, it will stand in a bank with practically vertical face, but when fully saturated with water tends to flow a horizontal surface, and is easily eroded and transported by running water. This latter property has a very direct bearing on the safety of the conduit, in view of the proximity of the aqueduct excavation.

Water leaking from the conduit under pressure tends to find an outlet through the intervening bank into the adjacent aqueduct, the bottom of which is about 5 ft. lower than the invert. This water erodes and transports the soil surrounding the conduit, removing its lateral support, and the leaks are a serious source of danger, so long as the aqueduct remains unwatered.

The only practical way to stop these leaks, in the opinion of the Board, is by filling the cracks from the interior. This, however, can only be done by unwatering the conduit. Under existing conditions, however, this latter cannot be done within a reasonable time owing to the fact that there is only one 12-in. pipe through which the conduit can be drained. The suction pipes of the pumps at the pumping station do not extend sufficiently low by several feet to permit the conduit being unwatered by pumping. We would, therefore, recommend that the installation of a new suction well or gallery, at least 6 ft. lower than the existing one, should be immediately constructed, and the suction correspondingly lowered. This arrangement would permit the conduit to be quickly unwatered, and the work of interior repairs proceeded with during short periods, and would also permit the conduit being run partially full of water.

Work on the Aqueduct.—Referring to the contract of the Cook Construction Company for the widening and deepening of the aqueduct, it is found that the contractor is required to construct reinforced concrete retaining walls along both sides of the aqueduct in the earth section, and plain concrete retaining walls in the rock section.

While the contractor is, in his contract, called upon to use extreme care and diligence in his work in order

not to endanger in any way the water supply conduit, and is particularly cautioned regarding the sections between Stations 10 and 14, and from 80 to 85, it is not found that there is any particular provision made by which the contractor is obliged to follow up his earth excavation immediately with the construction of the retaining walls. Moreover, the contract provides that the contractor construct test sections of the wall when ordered by the engineer and before proceeding with the general construction. This would seem to indicate that the city engineers did not expect the contractor to follow up his earth excavation very closely with the retaining walls. It also seems to indicate that the city engineers themselves were not quite satisfied that the wall as designed was sufficiently strong for the purpose intended.

It is obvious from what has already occurred and from the present condition of the north bank in the earth section, that unless the wall construction followed the excavation very closely, the conduit would be greatly endangered, as there are points east of where the break occurred where the plans show that the excavation was to be carried much closer to the conduit than at points already excavated.

As one of the recommendations, made immediately after the first inspection of the conduit by the Board and confirmed by its interim report, was to the effect that all work on the north side of the aqueduct should be suspended by the contractor for the time being, we have felt obliged, in preparing this report, to make an analysis of the design of the reinforced concrete retaining wall which the Cook contract provides shall be built in the earth section. From this analysis we have found that the wall would not be stable for the loads which we believe it prudent to assume it would have to sustain.

Another apparent weakness in this design is that the bottom of the concrete base is only 1 ft. 9 in. below the bottom of the canal. If the structure were left exposed during construction in the winter time, or if, at a later period, the canal should be emptied of water in the winter time, there would, we believe, be great danger of frost penetrating under the base, causing serious damage to the wall.

Conclusions.—From a review of the features which have been described in this report, we have arrived at the following conclusions:—

1. That the plans and specifications of the conduit did not call for sufficient reinforcement, nor is the steel properly placed in the concrete section, to provide a sufficient factor of safety, especially in view of the fact that the conduit would be the only means of supplying the city with water during the enlargement of the aqueduct.

2. That in the construction of the conduit the quality of the concrete and the workmanship generally were good, but that the weight and strength of the steel reinforcement was much less than called for by the specifications submitted to us.

3. That the insecurity of the conduit was greatly increased by the proximity of the excavation involved in carrying out Enlargement No. 2.

4. That the method of performing the work by means of a heavy drag-line excavator travelling on top of the bank above the conduit imposing a heavy vibrating load concurrently with the removal of the earth which provided lateral support to the conduit further endangered the structure.

5. That the leakage of water from the conduit is an additional source of danger at points where the conduit is located in easily eroded soil, and the excavation carried sufficiently close to permit the water finding an outlet into the aqueduct.

6. That the failure of the conduit was due to the proximity of the excavation, to the methods employed in the execution of the work, and to the inherent weakness of the conduit itself.

7. That the conduit, as a permanent means of supplying water to the city, is not now to be depended upon.

8. That it would be unsafe to proceed with any further excavation in the earth section on the north side of the aqueduct with the conduit in its present condition and while there is no other water supply available.

9. That is is unsafe to do any blasting in the rock section on the north side of the aqueduct.

10. That it is unsafe to allow the travelling excavators or locomotives or any other similar heavy machinery to be operated on or moved at any point over the top of the conduit.

11. That the reinforced concrete retaining wall as designed by the city and to be built by the Cook Construction Company along the banks of the aqueduct in the earth section is not, as designed, a safe structure to build for the purposes intended.

12. That a revision of the design of this wall, in order to make it safe, will greatly increase the cost of the project.

With the above facts as a basis, we beg to make the following recommendations:—

1. That before any further work is proceeded with, at least on the north side of the aqueduct, an investigation be made by a commission of engineers into the entire aqueduct scheme, which will include revised estimates of the cost of construction, and the quantity and cost of the power developed.

2. That the city at the earliest date possible make arrangements for providing a new and independent water supply of a suitable character, so located that it cannot be affected by any further accident which might happen to the present conduit.

3. That a permanent coffer-dam or intake be at once constructed at the entrance to the aqueduct including proper gates or sluices that may be required, so that the flow of water into the aqueduct may be at all times under control.

4. That until another suitable water supply has been provided, the present one should be kept continuously under observation so that in case the present leaks become serious prompt remedial measures may be taken.

5. That the suction pipes of the pumps at the pumping station be lowered by at least six feet as soon as possible so that the conduit may be run partly full or may be quickly emptied.

Respectfully submitted,

(Signed) J. A. JAMIESON,
R. S. LEA,
G. R. HECKLE.

[A detailed description of the emergency repairs to the break and the subsequent repair work is to follow as an appendix to the report.—Editor.]

A proposition, recently announced, which will ease considerably the meagre traffic facilities of Iceland, is a million-dollar railroad to be started in Iceland at an early date, extending from the capital, Reykjavik, in an easterly direction across the plain of Thingvala, a distance of about 58 miles, to the Olfusa Bridge. Ultimately it is proposed to extend this line to Thorsjaa, where the line will branch off in two directions, one going to the geysers and the other to Cerbak.

Coast to Coast

Bassano, Alta.—It is stated that the C.P.R.'s $9,000,000 dam will be completed at Bassano early in the spring, and water will be turned into the vast network of trenches.

Fort William, Ont.—The amended plans for the new C.N.R. station at Fort William show a brick and stone building, 143 by 24 feet; and the cost of the structure is estimated at $38,000.

Port Nelson, Ont.—Wireless signals from the new station at Port Nelson have been received at Le Pas, some 450 miles distant, showing that the plant of the new Hudson Bay terminal is now installed.

Windsor, Ont.—The towers of the Niagara power transmission line have reached Chatham, and all the tower foundations are constructed to Windsor, so that it is believed that by June, power will be in use in the latter city.

Fort William, Ont.—It is expected that this week will see the end of construction on the Stanley Avenue sewer at Fort William. The cost will be about $35,000 more than the original estimate of $54,000, due to an additional length of 600 feet added to the sewer since the contract was let, and also to the peculiar soil conditions which were encountered along the route of the sewer.

Montreal, Que.—At a recent meeting of the Montreal Chambre de Commerce, Mr. P. E. Lamarche, member for Nicolet, spoke in favor of the construction of the Georgian Bay canal, referring to the water power that might be developed from the project and which might earn enough to pay the interest and some of the sinking fund on the $150,000,000 which would be required to construct it. He also argued in reply to those who say the work will cost too much that it will justify itself just as the railways have done; that it will foster interprovincial trade, and besides forming a passage-way for the wheat, will enable coal to be sent to the West from Nova Scotia.

Toronto, Ont.—At the meeting of the Associated Boards of Trade on February 25 at Toronto, Mr. J. F. Black, Sudbury, advocated that the Hydro-Electric Commission be asked to proceed with the development of power in New Ontario, and that the Federal and Provincial Governments arrange to adopt this policy at an early date. A proposal to reforest waste lands that are useless for farming was approved by the board, and a resolution of five boards—Fort William, Port Arthur, Soo, Steelton, North Bay and Sudbury—was adopted, favoring Government assistance in mining and treatment of Canadian iron ore, such as will keep this trade in the Dominion, to be developed for the benefit of the Canadian people.

Montreal, Que.—The improvements to the harbor and terminal facilities at Montreal, contemplated by the Harbor Commissioners of Montreal to be carried out during the next 4 years, will call for an expenditure of $15,000,000. This year $3,500,000 will be utilized in developing the port, whereas last year $2,600,000 was consumed in this work. The exact programme for this year has not yet been decided, though it is believed that it will include the construction of two new freight and transportation sheds to accommodate the Hamburg-American and Canadian Northern weekly services; the electrification of the entire system of harbor railways; the elevation of the railway tracks between McGill Street and Victoria Pier; and the erection of a new mammoth warehouse at the foot of Morau Street and another at the foot of Beaudry Street. Plans adopted by the board call also for the extension of several piers, the erection of a new St. Lawrence bridge and the building of a new grain elevator, so as to give Montreal the largest storage capacity in the world.

Medicine Hat, Alta.—Contracts have been awarded by the city council of Medicine Hat for $65,000 worth of machinery and equipment at the new municipal power station, which will bring the total cost of that utility to approximately $500,000, including the modern and up-to-date pumping, generating and filtration system. Originally the new station was equipped with 2,400 h.p. gas-fired boilers, two 750 k.w. turbine alternators, and four 1,000,000-gallon filter beds, with the requisite high and low-lift pumping equipment. When the new machinery is installed and in running order later in the year, the station will be capable of generating about 4,000 h.p., and the filtration plant will handle 9,000,000 gallons of water each 24 hours. While the new power station has only been in commission two or three months, the steady and substantial industrial and municipal expansion has been such that additional machinery and equipment were essential, in order that the plant should not be seriously strained or rendered less effective by overloading in the immediate future.

Vancouver, B.C.—Mr. Frank Bowser, chairman of the Burrard Peninsula Joint Sewers Commission, has stated that approximately $2,000,000 will be expended in sewers for Greater Vancouver this year. Of this amount the approximate outlays will be $1,000,000 in Vancouver, $750,000 in South Vancouver, $100,000 in Point Grey, and $100,000 in Burnaby. In Vancouver the expenditures will include the purchase by the commission of the Balaclava Street, the Bridge Street and the China Street trunk sewers, at a cost of about $300,000. The work on the extension of the China Creek trunk will claim the expenditure of about $250,000, and the Clarke Drive outfall will entail an expenditure of something like $325,000. The Balaclava Street trunk sewer will be carried on from Ninth Avenue to the city boundary at Sixteenth Avenue, and a branch will be laid, probably along Tenth Avenue, as far east as the base of Shaughnessy Heights, to serve the territory in the declivity between the Kitsilano Hill and the Heights. In the extension of the main trunk sewer out to Central Park, this year's expenditures include work to cost something over $350,000, while another $200,000 will be paid for branches connecting with this work, all in South Vancouver. In Point Grey the commission will take over the Key Road sewer from the municipality at a cost of about $50,000, as well as undertake new work.

Sarnia, Ont.—As has been announced, plans are under consideration for an electric railway from a point in or near the town of Sarnia, down the scenic route along the bank of the St. Clair River through Corunna, Mooretown, Courtright, Sombra and Port Lambton, hence to Wallaceburg, where it will connect with MacKenzie and Mann's Wallaceburg, Chatham and Lake Erie Railway. From the village of Corunna a branch line will be constructed into Petrolea and probably further. The company contemplates the purchase of a charter already extant, which would give it power to construct the line of standard gauge railway; to acquire, charter and dispose of steam and other vessels, etc.; to construct, acquire and lease wharves, docks, elevators, warehouses, etc.; to operate a ferry line between Sarnia and Port Huron, and between Corunna, Stag Island and Marysville, Mich.; to operate a line of steamers from Sarnia down the St. Clair River; to erect and operate telephone and telegraph lines; and also to generate, transmit and sell power to the municipalities through which the line will pass. It is estimated that including all equipment, the construction of the line will cost about $1,000,000.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

OTTAWA BRANCH—CAN. SOC. C.E.

On February 5th, Mr. C. P. Edwards, general superintendent of Government Radio-telegraphs, Department of Naval Service, gave an illustrated address to the Ottawa members of the Canadian Society of Civil Engineers. About 350 were in attendance at the meeting, which was held in the Normal School hall. The lecture was accompanied by some practical demonstration by means of apparatus set up for the purpose.

Mr. J. W. W. Drysdale, of Glasgow, Scotland, read a paper before the branch on February 12th. His subject was Centrifugal Pumping Machinery* and brought out some interesting discussion.

The February 19th meeting took the form of a luncheon at the Russell Hotel. About 50 were in attendance. Mr. G. A. Mountain, chairman of the Branch, presided.

Some very promising papers have been arranged for presentation during the balance of the season. The "New Welland Ship Canal" will be described by Mr. J. L. Weller, of St. Catharines, chief engineer of the project, on the evening of March 5th. The paper will deal with the location, the history, and the most interesting engineering features of the canal, and will be illustrated with lantern views. Mr. E. S. Mattice, of Montreal, will lecture at a later date on "Steel Building Construction"; and Mr. Walter J. Francis, of Montreal, will give an address on Engineering Ethics.

*See *The Canadian Engineer*, February 12th, 1914.

CANADIAN MINING INSTITUTE.

The seventeenth annual meeting of the western branch of the Canadian Mining Institute was held in Vancouver, on February 20th. Delegates were present from all parts of the province, and several instructive papers and discussions on mining matters particularly affecting the province of British Columbia were heard.

INSTITUTE OF MINING ENGINEERS.

Before the American Institute of Mining Engineers in New York on Friday, February 20, Eugene Coste, M.E., geologist and mining engineer, of Calgary, read a paper dealing somewhat exhaustively with certain phases of oil and gas strata under the general title "Rock Disturbances Theory of Petroleum Emanations vs. the Anticlinal or Structural Theory of Petroleum Accumulations."

AMERICAN SOCIETY FOR TESTING MATERIALS.

The executive committee of the American Society for Testing Materials has announced that the seventeenth annual meeting will be held at Atlantic City, N.J., June 30 to July 4, 1914, with headquarters at the Hotel Traymore. As it is desired that papers and committee reports be printed and circulated in advance of the meeting, all manuscripts should be in the hands of the secretary-treasurer by April 15.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

PERSONALS.

J. CHALMERS, Commissioner of Public Works, Edmonton, is on a trip through Eastern Canada.

CYRIL G. SAVAGE was appointed secretary-treasurer of the Canadian British Insulated Co., Limited, Montreal, at a recent directors' meeting. Mr. Savage succeeds HAROLD BROWN, resigned.

E. BRYDONE-JACK, Winnipeg; H. J. DUFFIELD, Calgary; and A. BROOM, Montreal, are reported to have been recently elected to membership in the Institution of Civil Engineers of Great Britain.

W. J. WALKER, A.M.I.E.E., is delivering a series of eight weekly lectures to the members of the Electrical Society of Vancouver, dealing with the construction and maintenance of storage batteries and their practical application.

W. T. WOODROOFE, for the past 1½ years superintendent of the Edmonton Street Railway, has recently sent in his resignation, to take effect April 1st. Mr. Woodroofe was previously with the British Columbia Electric Railway Company.

FRANK DITCHFIELD, formerly general superintendent of the Canadian Car and Foundry Co., Limited, has joined the staff of the Mechanical Engineering Co., Limited, of Montreal, and will direct the affairs of the company's consulting engineering department.

ARTHUR H. BLANCHARD, M.Am.Soc.C.E., Professor in Charge of the Graduate Course in Highway Engineering at Columbia University, on February 19, 1914, delivered illustrated lectures at the Ohio State University on the subjects:—"Road Legislation, Present and Future," "Bituminous Surfaces and Bituminous Pavements" and "Foreign Highways."

OBITUARY.

JOHN O. BROWN, civil engineer and railway builder, died at Fredericton, N.B., on February 25th, at the age of 71. During his career he had been identified with the construction of several of the important lines in Canada and the United States. He built, owned, operated and finally sold out the Northern Railway, and was interested in the building of what is now a part of the Northern Division of the C.P.R. in Madawaska County, and also the Central Railway.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21383—February 19—Approving location of Kettle Valley Ry., between mileages 19.7 and 27.2, Hydraulic Summit west to Penticton, B.C.

21384—February 19—Approving revised location C.N.O.R. line of railway and land required for yards, in Tp. Ferris, Dist. of Nipissing, Ont., mileage 337 to 338.15 from Montreal.

21385—February 19—Authorizing C.P.R. to use and operate six (6) bridges, namely,—Over North Saskatchewan River at Edmonton, Alta.; No. 33.9, Alta. Div. Edmonton Subdivision; over Saskatchewan Ave., Edmonton, Alta.; over Jasper Ave., Edmonton, Alta.; No. 49.4, Alta. Div., Red Deer Subdivision, and No. 88.0, Alta. Div., Red Deer subdivision.

21386—February 19—Authorizing C.P.R. to construct spur for Massey-Harris Co., Limited, from a point on the southwesterly limit of right-of-way of Ry. Co.'s Main Line, Sask. Div., in Lot 4, Block 3, Bett's Subdivision, Yorkton, Sask.

21387—February 16—Directing that C.N.O.R. construct a permanent undercrossing, not less than 15 ft. wide and 13 ft. high, at west bent of trestle constructed by Co. through Henry Ray's farm in S. ½ of Lot 25, Con. 3, Tp. March, Ont., subject to certain conditions.

21388—February 21—Authorizing C.P.R. to use and operate Nine (9) bridges, Province of Ontario, on Eastern and Ontario Divisions, and Havelock, St. Thomas, Toronto, Hamilton and London Sub. Div.

21389—February 21—Authorizing C.N.O.R. to construct spur to property of Sun Brick Co., Ltd., in Lot 11, Con. 3, F.B., Tp. York, Co. York, Ontario, to be completed within six months from date of this Order.

21390—February 21—Authorizing G.T.R. to use and operate bridge No. 346, at mileage 198.46, on Sixth Dist. Eastern Division, at Napanee, Ont.

21391—February [illegible]—Approving detail plans of Edmonton, Dunvegan and B.C. Ry. Co.'s bridge proposed to be constructed across Athabasca River, at mileage 131 West of Edmonton.

21392—February 23—Authorizing Municipal Council of Village of Young, Sask., to construct, at own expense, Dublin St., in said Village, across C.P.R. tracks.

21393—February 23—Amending Order No. 19033, dated April 11th, 1913, by striking out words, "fifty per cent. of cost of work," in operative part of Order, and substituting words, "The C.L.O. and W. Ry. Co., and the G.T.R. Co. each to pay for span over its own track; fifty per cent. of cost of remainder of the work."

21394—February 23—Directing that C.P.R. flag all train movements over crossing of Atwater Ave., City of Montreal, Que., and locate highway crossing sign so that a good view can be had of same when approaching crossing in either direction.

21395—February 14—Approving City of Toronto Plan No. a-101, dated Nov. 8th, 1913, and marked Plan "A," showing bridge to be reconstructed over G.T.R. and C.P.R. at Strachan Ave., Toronto.

21396—Amending Order No. 21290, dated Jan. 29th, 1914, by striking out figures and words, "7.30 a.m. to 7.30 p.m." in third line of operative part of Order, and substituting therefor figures and words, "7 a.m. to 8 p.m."

21397—February 23—Authorizing G.T.R. to reconstruct bridge No. 63 carrying Ottawa Div. 31st Dist. of its railway over the Madawaska River, at Mile Post 171.41, near Arnprior, Ont. Provided pier to be abandoned be lowered to three feet below low water mark.

21398—February [illegible]—Approving proposed changes and alterations in V.V. and E. R. and Nav. Co.'s Main Line, part of original Sec. East line, Section 15, Tp. 16, to West line Tp. 26, B.C.

21399—February 23—Approving Can. Nor. Alta. Ry. Co.'s plans of stress sheet and general design of bridge at mileage 209.3, across Stony River, Sec. 35, Tp. 48, R. 28, W. 5 M., Alta.

21400—February 20—Authorizing T., H. and B. Ry. to divert two highways between Lot 5, Con. 12, and Lot 5, Con. 13, and Lots 6 and 5, Con. 12; to construct a right-angle crossing half-way between two crossings at present constructed between said Lots 6 and 5, Con. 12, and Lot 5, Cons. 12 and 13; And 2, Rescinding Order No. 20134, dated Aug. 16th, 1913, in so far as it authorizes diversion of highway between Lot 5, Con. 12, and Lot 5, Con. 13, Tp. Pelham, as set out in paragraph 4 of said Order.

21401—February 24—Approving locations of C.P.R. stations on Bassano Easterly Branch, Alta., namely, 1. Millicent, in S.W. ¼ Sec. 20-20-13, W. 4 M., and 2. Rosemary, N.E. ¼ Sec. 1-21-16, W. 4 M.

21402—February 24—Suspending, for present and pending investigation by Board, increased minima on building papers and pulpwood published in Supplement No. 40 to C.P.R. C.R.C. No. E. 2353, and supplement No. 28, to G.T.R. Tariff C.R.C. No. 2513.

21403—February 24—Authorizing the C.P.R. to construct, by means of a grade crossing, a diversion of road allowance across C.P.R. Main Line, Medicine Hat Subdiv., in Sec. 12, Twp. 12, Rge. 4, W. 4 M., Alta.

21404—February 24—Further extending until May 31st, 1914, the time within which sidings for the Otis-Fensom Elevator Co., at Hamilton, Ont., be constructed and completed.

21405—February 26—Further extending until June 30th, 1914, the time within which to complete the sidings for the Godson Contracting Co., in Lot No. 16, Con. 19, Twp. Darlington, Ont.

21406—February 24—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway, or spur, for the International Harvester Co., Lethbridge, Alta., from a point on the westerly limit of the C.P.R. Alta. Division, thence across Tenth Avenue, West, and along lane 206 in said City of Lethbridge.

21407—February 24—Authorizing the C.P.R. to construct, maintain, and operate an extension to siding for the C. S. Hyman Co., Ltmited, on Subdiv. Lots 3, 4, and 5, Block 304 A, London, Ont.

21408—February 26—Authorizing the Twp. of McKim, at its own expense, to construct and maintain highway crossing over the tracks of the C.P.R. in Lot 9, Con. 5, Twp. of McKim.

21409—February 26—Limiting the speed of trains over the crossing of Long St., by the G.T.R., at Chesley, to a rate not exceeding ten miles an hour.

21410—February 24—Authorizing the G.T.R. to construct, maintain, and operate extension of siding serving the premises of the British American Oil Co., Limited, commencing at a point on the G.T.R. tracks on the 150-foot roadway reservation, north of Keating's Channel, Ashbridge's Bay, Toronto, Ont., thence extending in a westerly direction to and into part of Block E, leased to B. A. Oil Co., Limited.

21411—February 24—Authorizing the G.T.R. to construct, maintain and operate branch line of railway, or siding, commencing at a point on the N. Div. of its railway on Lot 8, in the 1st Con. of Twp. of Chaffey, Dist. of Muskoka, Ont., and near Huntsville Station, thence extending in a northeasterly direction to and into the premises of Steven Brothers and Holmes, Brick Mnfs., on said Lot 8, thence extending easterly and adjoining the G.T.R. railway on said Lot 8.

21412—February 24—Authorizing C.N.R. to construct, maintain and operate a spur to serve the Alberta Agencies in Block 22, Glenora Subdiv., crossing Coot Street, Edmonton, Alta.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

SASKATCHEWAN RIVER IN MANITOBA

ITS TRIBUTE TO THE AVAILABLE POWER RESOURCES OF THE PROVINCE, AS REPORTED BY THE WATER POWER BRANCH, DEPARTMENT OF THE INTERIOR, TO THE PUBLIC UTILITIES COMMISSION.

THE Saskatchewan River enters Manitoba from the west, crossing the boundary between Saskatchewan and Manitoba almost directly opposite the north end of Lake Winnipeg. It enters the lake some 50 miles south of the lake's northerly end.

The area drained by the Saskatchewan River is in extent approximately 155,000 square miles, comprising a great portion of the western plains. The headwaters lie in the Rocky Mountains, and the drainage, though collected by many tributaries, is carried across the prairies by two large rivers known as the North and South Saskatchewan. The north branch heads in the Rockies west of Edmonton, while the southern branch heads in the same mountain range approximately on a line west of Medicine Hat. Intermediate between these two branches is situated the Red Deer River, a stream of almost as great an extent as the southern branch which it joins. The distance between the two rivers gradually diminishes with a consequent contraction of the drainage until about 30 miles below Prince Albert the junction of the north and south branches occurs. From the junction to Lake Winnipeg the flow is mostly confined to a single bed although in places it is divided into main and secondary channels, as at the Sepannock Channel, due to the generally flat and low-lying nature of the country, and to the consequent ease with which the river can and does at times change its bed. In Manitoba the river flows through a low-lying region in which occurs innumerable lakes and swamps. Great portions of the surrounding land are subject to floods during periods of high water. In the vicinity of Lake Winnipeg the river enters Cedar Lake and discharges from this lake into Crodd Lake, the Demi Charge Rapids occurring in this

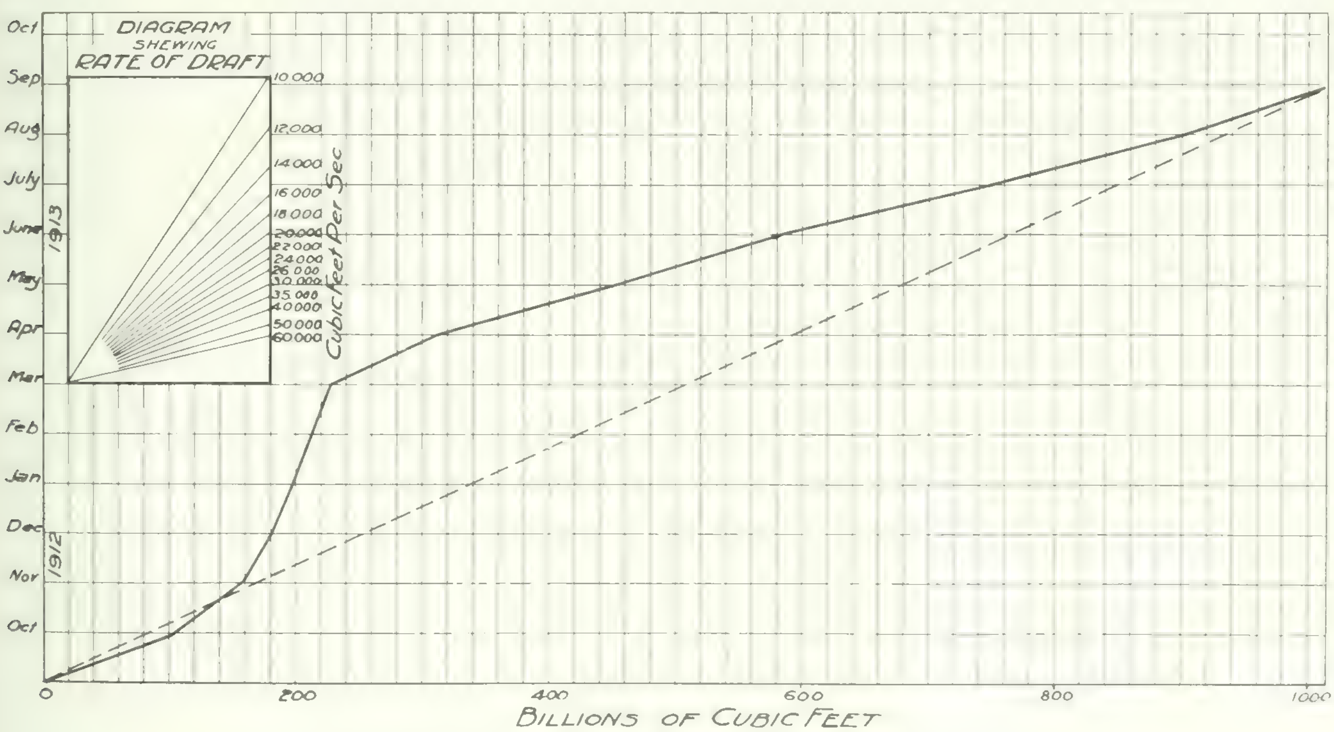

Fig. 1.—Mass Curve of Estimated Run-off, Saskatchewan River.

portion of the river. From Cross Lake to Lake Winnipeg a series of rapids occur comprising the Cross Lake rapids, Bed Rock Rapids and Grand Rapids.

Nature of the River and Banks.—In the vicinity of Le Pas, the banks range from 15 to 25 feet in height, but they become gradually lower as Cedar Lake is approached. The shores of this latter lake, as also the banks in the stretch of river to Cross Lake are rocky. From Cross Lake to the mouth of the river outcroppings of limestone occur at the water's edge. At Cross Lake Rapids this outcrop reaches a height of from 2 to 6 feet. In the vicinity of Red Rock Rapids the right bank is composed of limestone of some 6 feet in height, while the left shows no rock outcrops, being composed of clay and of some 12 feet in height. From Red Rock Rapids to Grand Rapids the banks, which are of clay, gradually become higher. At the latter rapids limestone is again encountered, rising in some places 30 feet above river level. A high ridge of lightly colored boulder clay overlying limestone rises to a height of some 60 feet about the mid point of Grand Rapids. This ridge which forms the barrier between Cedar Lake and Lake Winnipegosis crosses the Saskatchewan about three miles above the mouth. Near the foot of Grand Rapids a gully, which was probably as one time an overflow channel, sweeps inland from the left bank and returns to the main river a mile further down.

The river in Manitoba has an average width of about 1,000 feet; a minimum width of approximately 500 feet occurs in Grand Rapids, widening to 2,400 feet below the rapids. From the Manitoba boundary to Cedar Lake the river has a mud and gravel bottom with the occurrence of shifting bars. In the reaches below this section the bed of the river at various rapids is composed of limestone, while many beds of boulders occur in the intervening space.

A valuable timber growth occurs a slight distance above Le Pas, but from there to Cedar Lake the growth is stunted; and while a dense growth occurs around both Cedar and Cross Lakes, yet the timber occurring below this is largely of second growth.

High water usually comes during the months of July and August, while low water occurs in the winter months, the river reaching its lowest stage about the month of March. At Le Pas the range between these two periods is ordinarily some 15 feet, while at Grand Rapids the range is gradually lessened, being ordinarily from 4 to 5 feet with an extreme of some 6 feet. During the spring break-up the field ice of Lake Winnipeg occasionally becomes jammed at the mouth of the river, damming the outlet and causing a rise at the lake of from 12 to 15 feet.

The Saskatchewan is navigable above Grand Rapids, the Hudson's Bay Co. having at one period run steamers as far upstream as Edmonton. The river at present is navigated by gasoline launches from Le Pas to Cedar Lake. It is accessible by railroad at Le Pas and also by steamer at the mouth.

With the exception of Le Pas, no settlements of any size occur in the lower reaches of the river. A Hudson's Bay post is situated at Cedar Lake and a small settlement occurs at Grand Rapids.

Surveys of the River.—In 1884, Dr. Otto Klotz made a traverse of the river. The late R. E. Young made a survey of the settlement in the year 1903 and continued his traverse to the head of Grand Rapids, obtaining at the same time a profile of the portage. In 1909 a reconnaissance survey of the river was made from Le Pas to Lake Winnipeg by E. A. Forward, of the Public Works Department. The investigations made by the Water Power Branch of the Department of the Interior comprise a reconnaissance power survey by the late William Ogilvie in the year 1911, and in the following year a detailed survey of Grand Rapids and vicinity from Lake Winnipeg to Cross Lake. This latter survey was carried out by E. B. Patterson in charge of a field party of the Manitoba Power Survey. At the same time, a gauging station was established at Grand Rapids and discharge measurements were then and have since been obtained at this station.

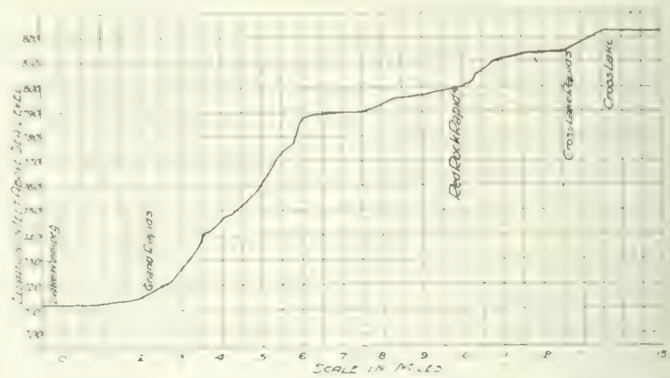

Fig. 2.—Profile of Saskatchewan River from Lake Winnipeg to Cross Lake.

Run-off.—No complete records are available for the precipitation in either the extreme western or eastern portion of the drainage. The following table, obtained from the meteorological records of Canada, gives the precipitation at various points throughout the central portion of the drainage, together with some few records of precipitation in the Rocky Mountains:—

Length of Record.

Station.	Period.	Beginning.	Depth, in inches.
Prince Albert	9 years	1903	17.13
Saskatoon	9 "	1904	14.45
McLeod	22 "	1884	12.58
Calgary	27 "	1885	15.17
Edmonton	28 "	1883	16.43
Banff	19 "	1891	20.3
Fort Dunvegan	4 "	1905	11.5

Float discharge measurements were made in the year 1909 by E. A. Forward at Le Pas, and also at Grand Rapids. This was followed by measurement made by the late William Ogilvie in the year 1911 at Grand Rapids. On August 8th, 1912, a gauging station was established at Grand Rapids by the Manitoba Hydrographic Survey, and on October 21st of the same year, a second station was established at Le Pas. It is estimated that for the year 1913, a low flow of 5,000 second-feet occurred during the month of February at Le Pas, and while several lakes and a great area of low-lying, swampy land occurs between this point and Grand Rapids which should give some regulation of the flow at the latter point, yet it has been assumed that a minimum flow of 5,000 second-feet also occurred at Grand Rapids. During July of 1913 a flood discharge of approximately 64,000 second-feet was recorded at Le Pas.

Storage Possibilities.—Three lakes are situated in the lower portion of the river system immediately above Grand Rapids; through two of these lakes—Ceder and Cross Lakes—the river flows, while Moose Lake is a tributary to the north. The combined area of these three lakes is estimated to be 970 square miles, being

made up as follows: Cross Lake, 39; Cedar Lake, 425, and Moose Lake, 513 square miles. While there might be a possibility of storage on these lakes, investigations are at present being made as to the reclamation of low lands in the vicinity of Cedar Lake through the lowering of the latter, which if carried out would forestall storage possibilities. Investigation is also being made as to the storage possibilities in the headwaters of the Saskatchewan River.

Making the assumption that the flow of the winter months from October 1st, 1913, to April 1st, 1914, would be similar to the same period during 1912-1913, mean curve studies (See Fig. 1) show that a storage of 305 billions of cubic feet would be necessary for a uniform flow of 32,000 second-feet. A 1-foot storage on Cross, Cedar and Moose Lakes would give approximately 27 billion cubic feet, indicating that a storage slightly over 10 feet would be necessary to create a uniform flow for a period similar to that found year ending September 30th, 1913.

Water Power.—An estimate of the power available at the three rapids, as indicated in Fig. 2, is given below. The power available has been based on a 80% efficiency and is also computed, 1st, for an estimated minimum flow of 5,000 second-feet, and 2nd, for a flow of 34,000 second-feet, this being the lowest monthly mean flow for the 6 highest months of the year ending September 30th, 1913, and extending from April to September, and the power as indicated refers only to this period.

No estimate has been made as to the additional power available during periods of low flow through any storage system:—

Estimated Horse-power on 80% Efficiency.

Possible power site.	Head in ft.	Minimum flow 5,000 sec.-ft.	Period 6 mos., April-Sept. 34,000 sec.-ft.
Demi Charge ..	15	6,808 h.p.	46,289 h.p.
Red Rock	15	6,808 h.p.	46,289 h.p.
Grand Rapids ..	80	36,305 h.p.	246,877 h.p.

Mayor Curley of Boston is advocating the consideration of the erection of a municipal asphalt and bitulithic paving plant, pointing out the significance of the fact that the Central Construction Company, which recently installed a plant for paving work, was the lowest bidder on work recently advertised by 10 per cent., bidding against one of the largest firms in the world.

In co-operation with Connecticut's plan for developing New London as an ocean port the United States War Department on January 19th recommended to Congress a channel 33 feet deep at mean low water and 600 feet wide, at an estimated cost of $330,000. The department recommended a first appropriation of $170,000 and a second of $160,000 to complete the work in two years, conditioned upon assurances that the State will carry out its terminal plans, for which it has already appropriated $1,000,000.

It has been reported at Buffalo that the Legislature proposes making an appropriation of $30,000 to cover the expense of a commission of 15 citizens who shall be known as the Peace Centenary Commission. The idea of the commission is to get up a plan for proper celebration of the 100 years' peace between the United States and other countries, barring Mexico. The project contemplated is the erection of a bridge which will connect Fort Erie and the Canadian border that shall be sufficiently large to accommodate the great traffic certain to use it.

THE DETERMINATION OF THE MAGNETIC DECLINATION, DIP AND TOTAL FORCE IN WESTERN CANADA.

Although the compass is not used in running lines on Dominion land surveys, it is a valuable accessory, especially in unexplored parts of the country. Where no line of definite bearing is available, it may be used advantageously as a finder of Polaris in daylight observations for azimuth. To accomplish this, however, a knowledge of the local magnetic declination is necessary; in other words, one must know within a reasonable degree of accuracy the angular interval between magnetic north and astronomic north.

The Topographical Surveys Branch, Department of the Interior published, in conjunction with the latest report of the Surveyor-General of Dominion Lands, a description of the determination of the magnetic declination, dip and total force in Western Canada, written by D. E. Chartrand, B.Sc., and reproduced in part as follows:—

The accurate determination of the magnetic elements in western Canada dates as far back as the year 1842, when Lieut. J. H. Lefroy, under the direction of the Royal Society, made a magnetic survey of that portion of the country. Magnetic observations were taken in the year 1887 by the Topographical Surveys Branch, but nothing further to any extent was done by it until 1908, when its Dominion land surveyors were instructed to observe the magnetic declination during the course of their surveys.

An isogonic map, on a very small scale, was published in 1904, chiefly from data obtained from Lefroy's survey and the 1887 observations of this Branch. Some information along the international boundary and around the Great Lakes was obtained from the United States Coast and Geodetic Survey.

In 1911 an isogonic map, on a very small scale, of that portion of Canada south of the 54th parallel of latitude was prepared and published in two sections, one for eastern Canada and the other for the western provinces. The declinations used for the western section were derived from the observations of this Branch. The sources of information for the compilation of the eastern section were: the Director of the Meteorological Service at Toronto, the British Admiralty charts, and the United States Coast and Geodetic Survey.

Area Covered.—As the survey operations under this Branch are confined entirely to the lands under the control of the Dominion government, the stations occupied since 1908 are limited to the provinces of Manitoba, Saskatchewan, Alberta and British Columbia. The districts where meridian, base line and subdivision surveys have been in operation since that date have been dotted with stations for the magnetic declination. A special effort has been made to gather magnetic data from the settled districts by means of travelling parties employed on miscellaneous surveys. These surveys generally cover a wide stretch of country and provide the only means now at our disposal of observing the magnetic elements in the settled parts of western Canada.

Compass Used for Declination.—The determination of the magnetic declination is made by means of a trough compass attached to the standards of the transit theodolite used on the Dominion land surveys. The needle is made as light as possible in order to reduce friction on the pivot to a minimum. The graduation of the end blocks consists of a single fine line, and readings are made on both ends of the needle. The range of readings of a first-class needle, well balanced, and in the hands

of a competent observer, can be expected not to exceed two minutes. The original method of attaching the compass to the standards consisted of a hook at one end and a thumb-screw at the other, but as this was not always found to be satisfactory, the hook was discarded, and the compass attached by thumb-screws at both ends.

Method of Observing.—The method adopted for the determination of the magnetic meridian is given in Appendix C of the Manual of Instructions for the Survey of Dominion Lands. The observer is instructed to proceed as follows and to note the following remarks:—

1. Place the instrument on a section line and after adjustment set the vernier to read the astronomical bearing of the line.

2. Release the lower clamp, direct the telescope on the line and fasten the lower clamp.

3. Release the vernier clamp and turn the vernier plate until the north end of the magnetic needle, observed with a magnifying glass, is seen exactly opposite the zero mark. Tap the trough lightly with the pencil or hit the milled parts of the foot-screws with the finger nail to be sure that the needle has taken the position of rest. Note the reading of the horizontal circle. Take several readings by repeating the operation.

4. Repeat operation No. 3 for the south end of the needle.

5. Enter in the notes the place of observation, date, hour of the day, weather and other remarks, if any. It is important to record auroras occurring within 24 hours of the time of observation.

The observations should be taken only when the needle is nearly stationary, say, in the afternoon after 5 p.m. if possible.

In taking the needle out of the trough, whether to rebalance it or to clean the agate, care should be taken to see that it is put back in its proper position. If replaced in the reverse position the index correction would be altered. For this reason, to safeguard against error, the position of the compass, whether "compass west" or "compass east," should be entered in the remarks after each observation when observing.

The returns should also state whether the observations are recorded in the mean time of the place or standard time.

The direction of the magnetic needle is subject to a daily fluctuation called the diurnal variation. During the greater part of the night the direction is not far from normal. In the early morning the north end of the needle in Canada moves towards the east, reaching its maximum deflection about 7 or 8 a.m. The motion is then reversed, the north end travelling westward and crossing the normal direction about 10 or 11 a.m. The extreme western position is reached in the afternoon, and then the needle comes back to its normal position at some time after 5 or 6 p.m. This march is subject to wide variations during magnetic storms. The magnitude of the diurnal variation is not constant. Observations at both eastern and western elongations of the needle on the same day, that is, between 7 and 8 a.m. and between 1 and 2 p.m., give the best results, and it is desirable that when convenient they may be taken then. This gives not only the best value for the declination, but also the diurnal variation, which it is very useful to know. Failing this, however, the best time to observe is after 5 p.m., when the needle is about in its normal position. It is true that the normal position is crossed generally between 10 and 11 a.m., but, the motion being very rapid and the time of crossing uncertain, the afternoon observation is preferable.

The place of observation must be at least three or four hundred yards away from wires carrying direct electric current. There must be no iron near the instrument. The observer must make sure that he has no iron or nickel on his person. If any magnetic object is not brought closer to the needle than fifteen or twenty times the distance at which an appreciable deflection is first produced, the effect on the needle is negligible in observations of this kind. Avoid transportation of the instrument on electric cars, as there are instances of the polarity of the needle being reversed in such an intense magnetic field.

If the needle is sluggish the observation cannot be accurate. The sluggishness is generally due to a dull pivot or a scratched cap. To keep both in proper condition the needle must always be lowered gently on its pivot and never be allowed to play except when actually in use.

Instrument Constant.—Through the courtesy of the Director of the Meteorological Service at Toronto, the index correction of every instrument used for observing was determined both at the beginning and at the close of the survey season, whenever possible. If a serious discrepancy was found between the two determinations, it was investigated and the observations taken with the instrument rejected unless the cause of the discrepancy could be satisfactorily explained.

Reduction of Observations.—In order to give a character of homogeneity to the declination observations, a reduction to a common epoch had to be applied to the observed data. To accomplish this a knowledge of the diurnal and secular variation is necessary. Again, as the diurnal variation is subject to extreme fluctuations, magnetic storms must be detected. The only method at our disposal for reduction was making use of the daily records of the declinometer at Agincourt, but the observatory being far away from where our observations had been taken, it was thought advisable to compare by actual experiments the fluctuations of the compass in western Canada and those at Agincourt. An observer was instructed to observe the magnetic declination at Rosthern, Sask., during the whole of November, 1910. Rosthern was chosen on account of being advantageously situated as a base station. The observations were taken from 7 a.m. to 4 p.m. at periods ranging from half an hour to one hour, care being taken to observe the needle at its two elongations. The work was carried out in a small silk tent in order to shelter the instrument from the influence of the wind and storms.

A comparison of the results of these observations with a diurnal variation observation taken at Jasmin, Sask., on July 10th, 1910, disclosed a diurnal range of the compass in July almost double of that at Rosthern in November.

Later, in the office, copies of the photographic traces of the declinometer at Agincourt were made for the days on which diurnal variation observations had been taken in the western provinces. On these copies were plotted the diurnal variation observations taken in the West so as to correspond in mean local time to the traces of the declinometer, and the points were joined by straight lines. From this investigation useful information was derived for the reduction of our magnetic declinations. According to our expectations, mostly all magnetic disturbances shown on the traces of the declinometer were recorded on the diurnal variation curve, and both occurred at practically the same instant.

In applying reductions the observations have been reduced to the mean of the month of the year in which they were taken. This was done in the following way:

A tabulation of the mean monthly declinations of each year was obtained from the magnetic observatory at Agincourt. The declination, for the corresponding date and mean local time at which the observation to be reduced was taken, was scaled from the trace of the declinometer at Agincourt. If the trace showed the declination then fairly steady, the difference between the mean declination of the month and the actual declination scaled from the trace was applied as a correction to the observation.

To reduce an observation to January of the same year, the difference between the mean declination of the month in which the observation was taken and the mean declination of January was applied to the observation reduced to the mean of the month.

In the absence of any definite knowledge of the secular variation a plus correction of three minutes per year, which agrees closely with the mean secular variation of the corresponding western portion of the United States as shown on the isogonic map of the United States Coast and Geodetic Survey, published in 1905, was adopted for the reduction of our declination observations to January 1st, 1912. From the few stations in the West which have been reoccupied this would appear to be a close approximation, and the maximum error from this general assumption cannot be large, as the period for reduction covers only three years.

Dip and Total Force.—During the season 1908 dip and total force observations were taken by Mr. J. E. Morrier, D.L.S., at Norway House, Oxford House, Fort Churchill and York Factory.

In 1910 similar observations were taken by Mr. C. Engler, D.L.S., during his trip from Athabaska Landing to Fort Smith, and subsequently by Mr. J. A. Cote at different points between Edmonton and Calgary. Unfortunately the results of these observations were lost during a fire at Carstairs, Alberta.

During the miscellaneous surveys made by Mr. P. A. Carson, D.L.S., in 1910, about 24 stations were occupied for dip and total intensity, between Swan River, Man., and Lashburn, Sask. Every complete observation consisted of a dip, a total force and a dip, the mean dip being used in working out the total force. This complete observation was generally duplicated at every station. In some instances the same station was reoccupied during the season and the results compared with those already obtained.

The instruments used for the determination of these magnetic elements were Dover dip circles, the constants of which were determined both before and after every season's work. The total force constant was the mean of at least six observations.

The following are the directions for the use of the dip circle and attachments in observing for magnetic declination, dip and total force.

The conditions to be satisfied in choosing a magnetic station are freedom from present and probable future local disturbance, combined with convenience of access. Proximity of electric railways, masses of iron or steel, gas or water pipes, buildings of stone or brick, should be avoided. A quarter of a mile from the first, 500 feet from the second, 200 feet from the third and fourth may be considered safe distances. The station should be at least 50 feet from any kind of building. If any doubt arises in the selection of a station on account of the possible existence of local disturbances, two intervisible points a hundred yards or more apart should be selected and the magnetic bearing of the line joining them observed at both. A lack of agreement between the two results is evidence of local disturbance.

When taking the observations, the instrument box, especially the bar magnets, should be 40 or 50 feet away for the declination observation and 25 or 30 feet for the dip and total force observations. All knives, etc., should be removed from the person. It should be noted also that iron is frequently present in buttons, hats, neckties, etc.

Care should be taken to keep the instrument in good adjustment, clean and free from dust. A camel hair brush, pith, chamois and tissue paper are supplied for that purpose.

The dipping needles should be carefully guarded against moisture, and after use should always be wiped dry with chamois or tissue paper. They should be put back in the box with poles of opposite polarity at the same end and should be magnetized afresh for each station.

The bar magnets should be touched with the hands as little as possible and should always be wiped with chamois or tissue paper after the observation to prevent rusting. They should not be allowed to touch each other except at their opposite poles and, when placed in the box, the ends of opposite polarity should be connected by a soft iron armature.

The instrument is levelled in the ordinary way with the plate level.

The trough compass should be attached to the upper horizontal plate by means of the two thumb-screws and the telescope to the vernier arms of the vertical circle. The observation for magnetic declination is then taken and recorded in accordance with the instruments given for magnetic declination observations with the D.L.S. pattern transit.

The magnetic meridian may also be determined by means of the dipping needle. Set the vertical circle verniers to read 90° and revolve the instrument in azimuth until the needle is bisected by the microscopes and read the horizontal circle. As the dipping needle points vertically when in the magnetic prime vertical, in this way the magnetic prime vertical is found and by applying 90° the magnetic meridian.

The magnetic meridian found in this manner is sufficiently accurate, however, only for the dip and total force observations. The former method is preferable and should always be adopted when possible.

The needles for the dip observations are carried on the lid of the instrument box. Taking out one of these needles carefully wipe with tissue paper and clean the pivots with pith and having also carefully cleaned the agate planes in the box with pith, place the needle on the brass v's with the face of the needle to the face of the instrument. (The face of the needle is that side which is lettered, the face of the instrument that side which is graduated.) Turn the instrument in azimuth until it lies in the magnetic meridian (previously determined in the declination observation) and with its face to the east, and lower the needle gently on the agate planes. It will now swing in the approximate position of the dip. When it settles it ought to be slightly raised and lowered once or twice by means of the screw, so as to ensure its being exactly in the centre of the instrument. The vernier of the vertical circle is now turned until the north, that is the lower end, is seen to be bisected by the cross hair of the microscope; the lower vernier is then read. Similarly, the upper end is bisected by the upper microscope and the upper vernier read; the needle is then slightly disturbed by the screw and the readings repeated until there are three readings for each end. The instrument is now turned 180° in azimuth so that the face of the instrument

is now west and the same number of readings taken for this position. The needle is then taken out of the glass box and reversed end for end of its axis, so that it faces the other way. The six readings are again taken as before for both ends of the needle.

The needle is then taken out of the box, and its polarity reversed in the following manner: Put the needle on the reversing block, face up and secure by the brass centre piece which is intended to protect the axis. Place the reversing block so that the north end of the needle will be on the right hand and the south end on the left. Now take the bar magnets one in each hand, the north pole of the magnet in the right hand lowermost and south pole of the magnet in the left hand, and bring the opposite poles of the two magnets down on the needle, near its centre and one on each side of the brass centre piece. Draw them slowly and steadily outwards over the needle, carrying them over its ends and lifting them some inches above the level of the needle, bring them back to the middle position again and repeat. This should be done five times. Care should be taken to have the motion as nearly parallel to the axis of the needle as possible; the ledge on each side of the reversing block is intended to act as a guide for the magnets to ensure this. The needle is then put face down in the reversing block and the operation repeated in the same way. The polarity of the needle will then be completely reversed.

The observations taken before reversal are now repeated. The mean of the observed inclinations in the eight positions is the dip.

It will be noticed that the mean resulting dip will, by the reversal of the dip circle, be free from any small error in the verticality of vertical axis and also eliminate index error of vertical circle; that the reversal of the face of the needle on the agates will eliminate the error caused by any want of perpendicularity of the axis of the needle to the needle; that the reversal of the polarity will correct for any want of balance of the two ends of the needle.

Total Force.—The total intensity may be determined with a dip circle by Lloyd's method when suitable standardization observations have been made at a station where the dip and intensity are known. This method involves first the determination of the angle of dip with a loaded needle, and second, a determination of the angle through which another needle is deflected by the loaded needle when the latter is placed at right angles to it in the place provided between the reading microscopes and protected by the brass shield. As the determination of total intensity by this method is relative, it is necessary to guard, as far as possible, against any change in the magnetism of the two needles and to use the same weight in the field as during the standardization observations. Their polarities must never be reversed, therefore, and they must not be allowed in close proximity to the bar magnets when these are being used to reverse the polarity of the regular dip needles. The needle which is weighted with the small wire is the loaded needle and is called the statical needle; the other is called the dipping needle. Neither of these needles must ever be touched with the bar magnets. Turn the instrument into the magnetic meridian with its face to the east. Revolve the vertical verniers until the tangent screw points to the north. By means of the small brass clips, attach the statical needle to the vernier plate with its face to the east and its north end next to the tangent screw and put the brass protecting shield in position over it. Place the dipping needle in the usual way on the agate planes, now, moving the vernier arms, read the inclination of the swinging needle as before, both north and south ends, then reverse the vertical vernier plate so that the tangent screw is south of the centre and read the inclination again. It should be noted here that the vertical circle is graduated into quadrants, from 0 to 90 degrees, and that these inclinations should always be read from the north zero, so that if in the former part of the observation, the north end of the dipping needle should be deflected by the statical needle past the vertical line, the reading to be entered is 180 degrees less the actual vernier reading, and, if in the latter part of the observation, the north end of the dipping needle be deflected above the horizontal, the vernier must be entered with a minus sign. The algebraic difference of the two readings is twice the deflection.

Frequency and Time of Observations.—The observations should be taken at least twice at each station whenever possible. Should the two observations not agree within 5 or 6 minutes a third observation should be taken. The most desirable time of day to observe is about the time of eastern and western extremes of declination, say, at 8 a.m. and 1 p.m., and it is suggested that when convenient these times be adopted.

Suitable forms for the observations are provided. The constant "A" used in the form is a constant for the two total force needles. That and the index correction to the compass have to be determined at the magnetic observatory at Agincourt.

Coal is produced commercially in only three of the numerous coal fields of British Columbia—namely, on Vancouver Island, in Nicola, and in the neighboring Similkameen district, and in the Crow's Nest section of southeast Kootenay. Production was adversely affected in 1913 by a strike of miners and other employees in Vancouver Island coal mines, so that the output of those mines was less by 596,000 long tons than in 1912. However, there was an increase at the other fields, so that the net gross production of coal—that is, of the quantity including coal made into coke—was about 450,000 tons less than the total for the previous year, the respective totals having been, for 1913, 2,576,071 tons of 2,240 lbs., and for 1912, 3,025,709 tons. The quantity of coal made into coke was 440,091 tons in 1913, as compared with 396,905 in 1912. The net production of coal disposed of as such was, in 1913, 2,125,980 tons, and in 1912 2,628,804. A summary of the production of coal in the several districts follows:

	Tons of 2,240 lbs.
Vancouver Island mines	962,620
Nicola and Similkameen mines	202,708
Southeast Kootenay	1,350,683
Total production (gross)	2,576,671

According to Consul Felix S. S. Johnson, Kingston, Ont. (United States Consular Report), the success of experimental work conducted by the Canadian Government in the manufacture of peat, has resulted in the fact that there are now two private concerns producing peat, one at Alfred, Ontario, and the other at Farnham, Quebec. The product is said to be satisfactory for use in grates and for cooking purposes. In connection with the new industry the Canadian Government will experiment with the production of gas and electrical energy from peat. At the fuel testing plant in Toronto a 60 horsepower gas producer engine is operated on gas from peat. If these experiments are successful, sections of the central peat-producing districts of Canada where water power is not available will be able to obtain power from a series of these gas-producer engines.

PAVEMENT WORK IN ST. JOHN, N.B.

DETAILS OF SPECIAL DESIGN AND CONSTRUCTION—ADAPTED RAIL SECTIONS, TRACK BASINS, ETC.—NOTES ON EQUIPMENT AND METHODS EMPLOYED.

THE following is a general description of pavements laid and paving methods employed in the City of St. John, N.B., during 1913.

At the outset of the season the Public Works Department had mapped out a programme of about 30,000 sq. yds. of pavement to be laid under the Local Improvement Act. When the time had arrived to call for tenders, however, the yardage was reduced to about 5,000 yds. This is accounted for by the fact that the owners of one-third of the total abutting frontage had the necessary power to petition and stop the laying of any pavement under the Act which provided that the abutters should pay one-half and the city the other half of the total cost of the pavement. It may here be stated that the present Commissioner of Public Works has had framed a new Act in which it is provided that sixty per cent. of the abutting frontage shall be necessary to stop the laying of any pavement. Even this Act does not give the city the necessary authority to force a single yard of pavement where it might be absolutely needed.

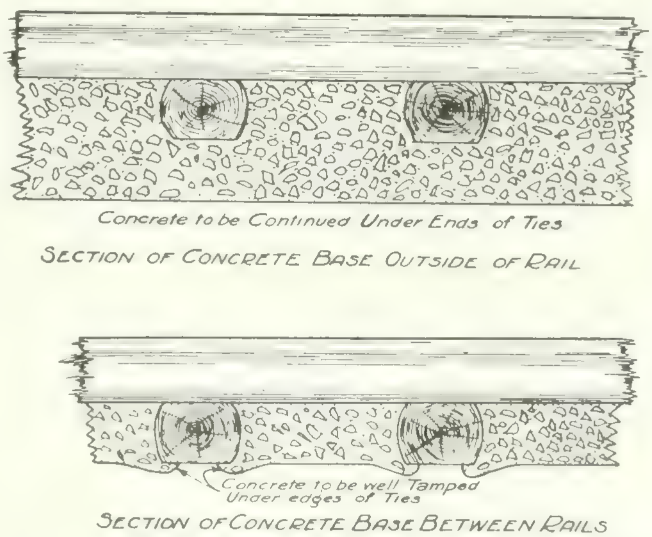

Fig. 1.—Sections of Concrete Base Adjacent to Rails.

With the small yardage above noted as being left it was decided that it would be useless to call for bids on sheet asphalt as recommended for these streets. So, a split was made and tenders asked for the concrete base, brick and granite track sections, there being local contractors in this line of work. It was decided the asphalt surface could be laid by city forces by day labor.

Contracts were accordingly let for concrete and setts. Shortly afterwards some other streets asked for pavements, which brought the quantity up to approximately 12,000 yds. As these streets were all suitable for a smooth pavement, a 2-inch bitulithic surface was contracted for, and in one case both surface and base was laid by the contractors for this material.

The general design of pavement laid during the past year is about the same as that adopted in most places where bitulithic pavement has been laid. It will, therefore, not be necessary to elaborate upon the design with the exception of the few following points. In the specifications, Mr. G. N. Hatfield, the City Road Engineer, has defined the results to be obtained leaving as far as possible to the contractor the methods to be employed. At the present time there is no local contractor equipped with any modern street paving machinery except a concrete mixer. The only road rollers available are the property of the city, which are necessarily hired out to enable the local contractors to bid upon the work.

Perhaps the only real departure from the general line of construction has been performed in the track section of some of the streets paved. To this work the accompanying illustrations chiefly allude. The concrete, as shown in Fig. 1, is not carried continuously under the ties between the rails, the specifications calling for the ties to be thoroughly tamped with concrete. But from

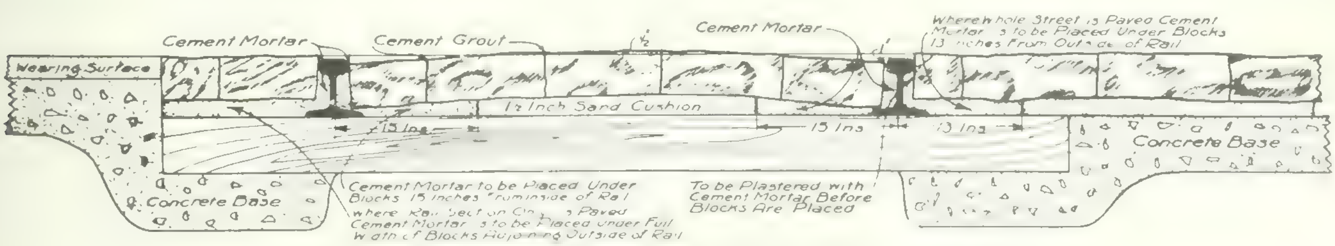

Fig. 2.—Detail of Rail Section for Granite Block Pavement.

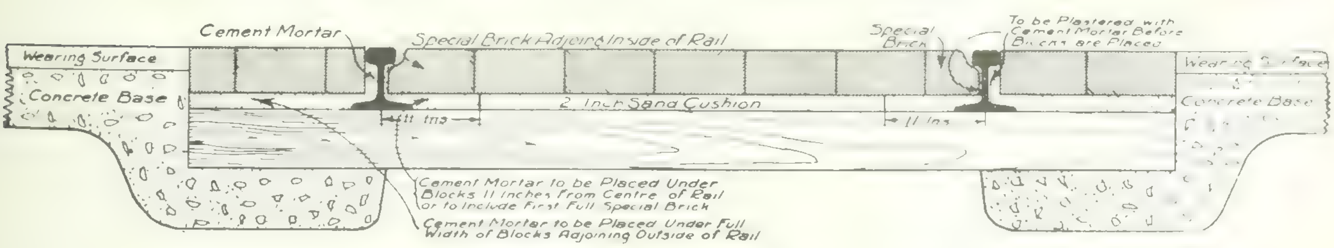

Fig. 3.—Detail of Rail Section for Vitrified Brick or Scoria Block Pavements.

the centre of rail to the outside end of ties the concrete is so placed that it is continuous under this section. In the opinion of the City Road Engineer the extra work and material is unnecessary between the rails if the ties are well supported under the rails and outside ends. Experience in railroading has shown that if all ties are well

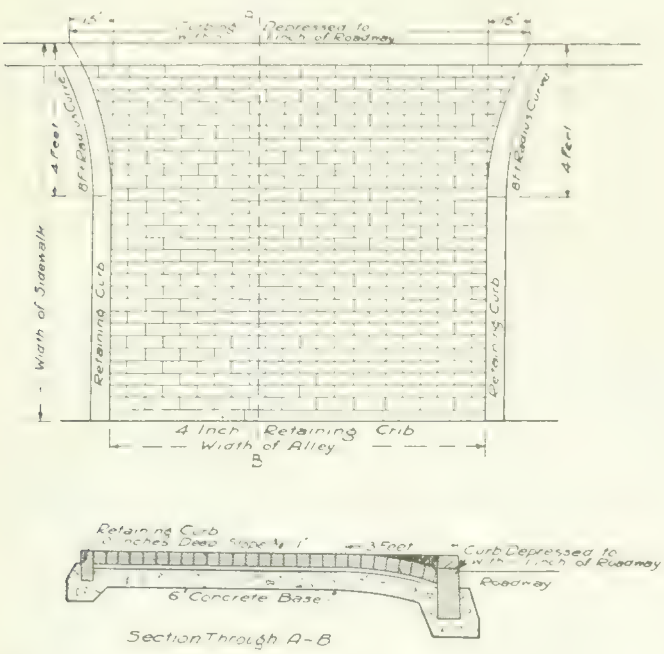

Fig. 4.—Plan and Section of Type of Paved Alley and Street Intersection Used in St. John, N.B.

tamped on the outside end and under the rails, it is inadvisable that they be extensively tamped between the rails. It has been noted on numerous occasions that railroad ties have snapped in the centre because too much attention had been given to the tamping of the section between rails. Moreover, it has been found that calling for continuous concrete under the ties has added twenty-five to thirty cents per sq. yd. to granite pavement. Again, it proves a continuous round of trouble to the inspector trying to compel the contractor to fulfil this part of the specifications. On the latter's behalf it may be stated that it certainly is slow and irksome work to dig under the ties laid in old macadam.

For a wearing surface between car rails and eighteen inches outside granite block has generally been adopted, but during the last two seasons vitrified brick has been laid on two streets. In all cases up to 1913 the blocks and bricks were paved flush with the top of rails, leaving a rectangular groove for the flange of car wheels. In both cases this method has proved rather unsatisfactory as the cement grout which was filled up to the ball of the rail has become badly rutted in places, and the vitrified bricks were soon badly spalled or broken, being unable to stand the blows of traffic in this exposed condition.

To overcome the difficulty where granite blocks were used the groove was formed as narrow as possible, which was found to be 1¼ in. This method is evidently an improvement, but from all indications will not prove entirely satisfactory. During last season's work in laying granite block the rectangular groove was abolished, and the blocks set in under the ball of the rail and crowned up at the centre to ½ in. above the top of rail, as shown in Fig. 2. The camber was made as acute as possible adjoining the rails, so that on the flat grades the track section would not have the appearance of being entirely flooded during wet weather. The water would be confined to a comparatively narrow section adjoining the rails. Where bricks have been employed specially grooved scoria blocks have been used adjoining the rails, as shown in Fig. 3. To date both of these methods have proven very satisfactory.

The above difficulty could otherwise be overcome by requiring the tramway companies to supply the necessary groove by using a heavily grooved rail.

As a guide to the contractors in excavating and laying pavements several methods have been employed, such as a template. This is used where track is placed in the centre of a roadway which was first graded and used as a datum for the template, the other end being supported and moved along the top of the curbing. Where the cross-section of the street was so irregular that a single template could not be used iron pins were placed in the section every twenty feet and in streets with no rails the ordinates were computed from a cord tightly stretched from curb to curb. By this method the finished work could be readily checked and errors, if any, placed where they belong. In the same way the template proved an undisputed judge.

For pavements laid by the city forces a template was designed which meets any case to which the formula for an eccentric crown is applicable. This is shown in Fig. 5. The section formed by this template is two straight slopes joined with a short vertical curve which might be much shorter. Such a section will tend to distribute traffic as the very centre will be the least pleasant to

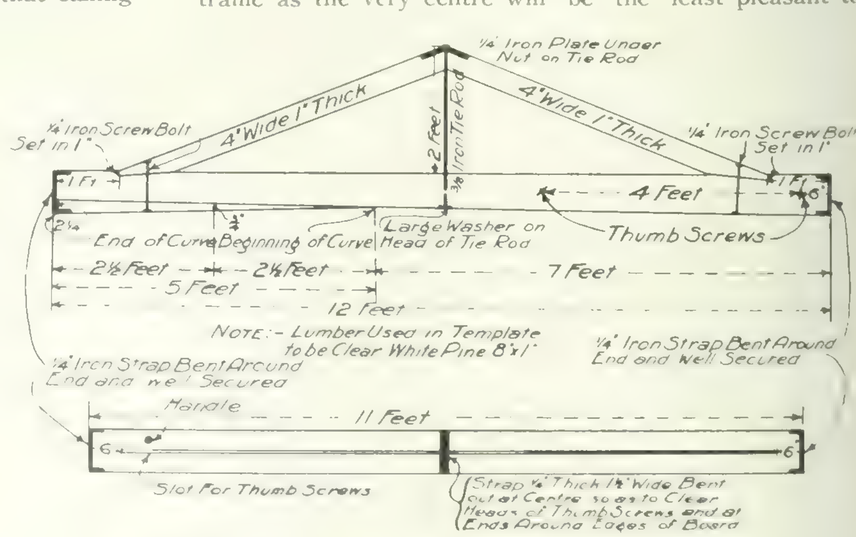

Fig. 5.—Details of Template Used by City of St. John, N.B., in Pavement Laying.

horses. On this template there is attached a small level which is set to a crown of one-fiftieth of the total width of the roadway, and also graduated to different crowns as far as possible. No doubt a metal frame could be

employed to hold the bubble with an adjustable thumb screw for changing the height of crown. By means of this template the foreman can crown the street by working from the opposite curbs or gutters, and if either of these does not properly exist all that he requires are a few pegs along the centre line of crown. The template

was changed, as noted above, it presented no handicap to the successful use of the basin.

From a study of the diagrammatical illustrations, it may appear to some that there is a greater surface of cover than conditions, considered with respect to expense, warrant. It is quite desirable, nevertheless, to

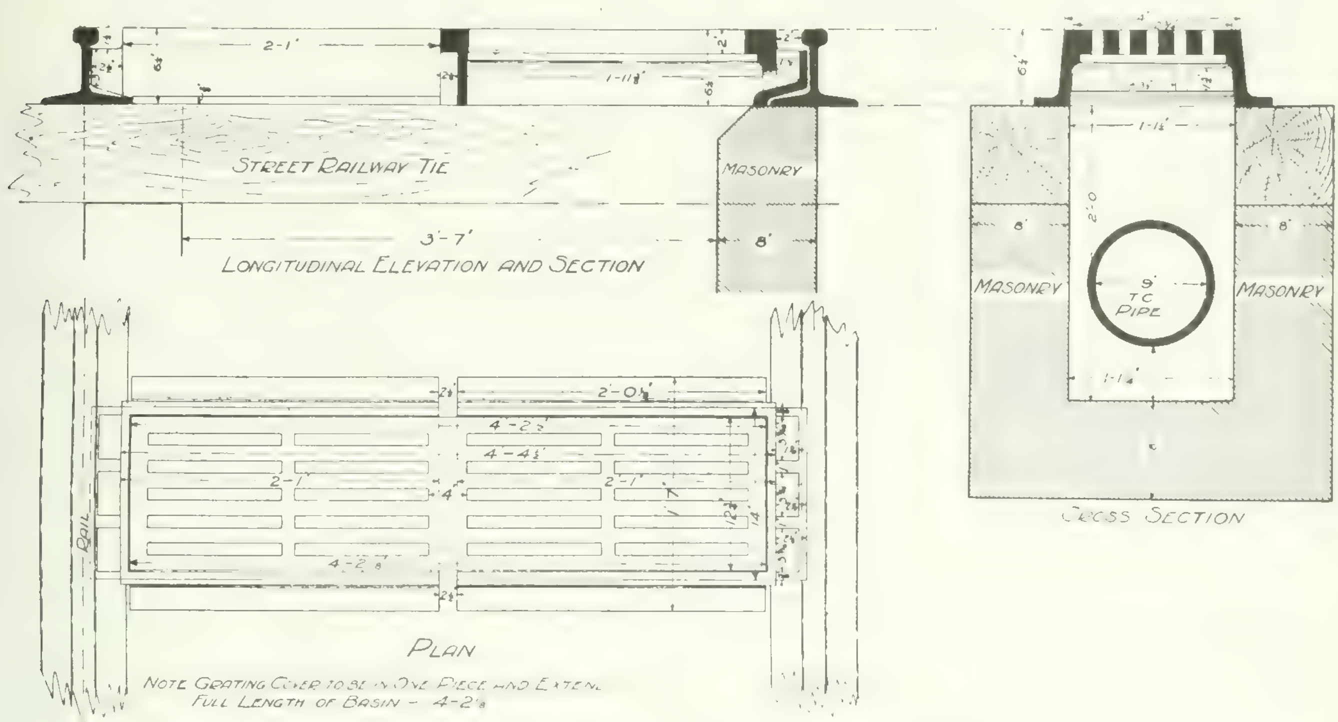

Fig. 6.—Plan and Sections of Track Basin, St. John, N.B.

is designed to meet the conditions of a medium crown, and when changed to suit others it is not absolutely correct from a theoretical standpoint. No appreciable error is involved, however, when so used in practice.

Fig. 6 illustrates a form of track basin designed last season. Several basins of this pattern have been placed

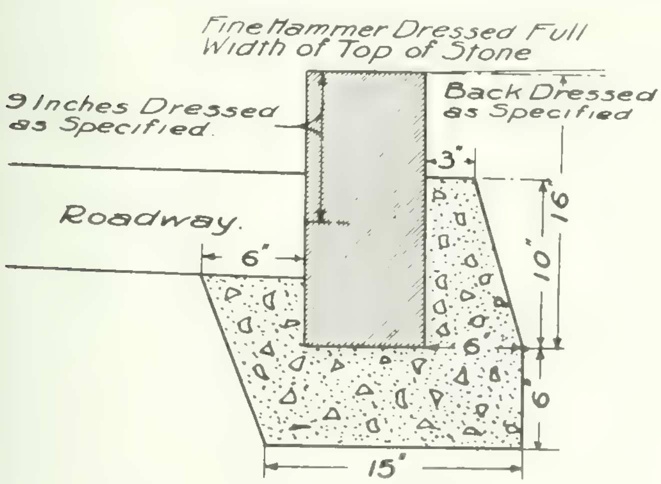

Fig. 7.—Details of Curb Setting.

and are proving very satisfactory. With little attention necessary, they take care of all water which runs along the groove provided for the car wheel flanges, as shown in Figs. 2 and 3. Although the style of track section

have a comparatively large pit to accommodate the silt and refuse which reaches it. Provision must also be made for easy cleaning. With these points in view it was decided to specify a cover of perforated iron. It can be readily lifted, and when winter thaws occasion

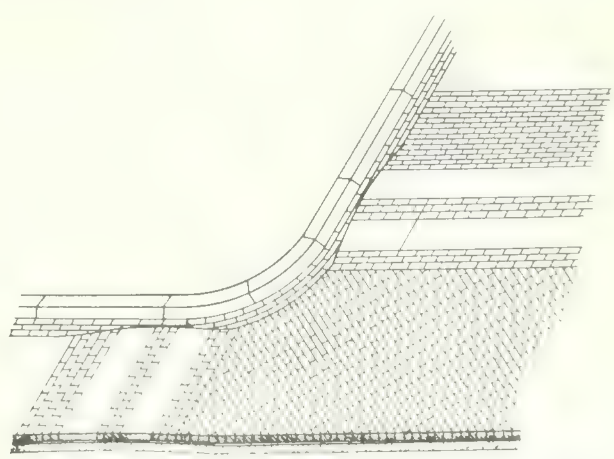

Fig. 8.—View Showing Setting of Bridge Stones at Street Corners.

excess of water with the trackway somewhat banked up with snow, these large gratings will readily take care of it.

The designs are those of Mr. G. N. Hatfield, City Road Engineer, to whom we are indebted for the above information and drawings.

THE PRESENT STATUS OF SANITARY ENGINEERING.*

By John W. Hill, C.E.,
President of the Ohio State Board of Health.

THE sanitation of cities is fast becoming an art, and the various features of sanitary work are being by degrees reduced to a science, so that certain steps can now be taken by a municipality for the collection and reduction of wastes—the collection and disposal of sewage—and for improvement of public water supply with positive assurance of success. Some difficulty has been experienced in the reduction of city wastes and disposal of sewage, partly by reason of the attempt to realize a profit on the operations and partly by the complex character of the substances to be handled. Setting aside profit and adopting the reduction processes to the materials to be destroyed or rendered innocuous, and allowing the sanitary rather than the commercial interest to prevail, satisfactory results can now in nearly every instance be expected.

Some cities, like Boston and New York, can impound water from unpolluted watersheds, in great reservoirs, at an elevation which will furnish gravity pressure for a low service supply, and this water will be purveyed in its natural condition, while other cities like Cleveland, Cincinnati, Chicago and St. Louis are compelled to draw from nearby polluted sources.

Gravity water supplies are not always pure and wholesome, and pumping sources of great capacity are not always impure and unwholesome, although the exceptions to the latter proposition are rare. The water supplies of Cincinnati, Philadelphia and Hamburg are obtained from seriously polluted sources, but by filtration the water is made safe for domestic use.

The Ohio River at Cincinnati, the Schuylkill and Delaware Rivers at Philadelphia and the Elbe River at Hamburg are badly sewage polluted streams at the intakes of these several waterworks. But by resorting to methods of purification which long time and broad experience have shown to be reliable, these polluted waters have been rendered as safe as the water flowing at the headwaters of these streams.

Surface water from unprotected watersheds is seldom safe to drink without boiling or filtration, and as the water supply of a whole city cannot conveniently or cheaply be boiled before use, filtration is the only recognized method by which purification and clarification can be accomplished. The use of slaked lime and iron, as at St. Louis, or of hypochlorite of soda or bleaching powder, as at Cleveland, cannot at this time lay claim to be considered as substitutes for filtration, although both are at times and under some conditions useful and valuable adjuncts of filtration. Free chlorine as applied at the Cincinnati filtration works, or chlorine gas as used at Wilmington and Delaware, and ozone as used at St. Petersburg, Russia, and on a small scale in some of the waterworks of Holland, are safeguards to doubtfully filtered waters, and are to be commended as aids to the broader and older methods of water purification.

The removal of all, or even of the pathogenic forms of bacteria from a polluted water by ozone or chlorine or by an electric current does not satisfy the requirements of modern sanitation. People will not drink dirty water, even if is certified as pure and safe, and filtration is the only recognized method capable of broad application, which will render a turbid water clear, safe and attractive. Filters of the slow sand or of the rapid type are capable when skilfully managed, of converting a polluted water into a safe drinking water, but the skilful management is not always forthcoming, so that some additional treatment to supplement filtration has come to be considered as desirable in some instances, and necessary in others, to render public water supplies absolutely safe.

The purification of a previously polluted water supply, however, does not solve the whole problem of the safety of the water as regards typhoid fever at least, nor perhaps as regards some other diseases known to be water borne. Pure water cannot be distributed through foul mains and remain pure, and some thought must be given to the influence of old water pipes containing deposits from polluted water which has flowed through them for years before the water supply was filtered or before pure water from a natural source was substituted.

The writer and others who have had to operate large city filtration works have sought information and have speculated on this point, and in the case of the filters for West Philadelphia, the typhoid statistics of that district of the city, seemed to show that ninety days after the distribution system began to receive the filtered Schuylkill water, all external evidence indicated that the old deposits were washed out of the pipes or that all noxious matters had been removed from them. Similar experience at various places, including London and Hamburg, have been received from abroad. But later experience elsewhere than Philadelphia, convinces me that complete safety from typhoid fever from a water source requires that the old deposits from a polluted water supply should be wholly and certainly removed from the mains, before they can be regarded as safe carriers of a purified or pure water. Recent experience seems to show that even seven years is not enough to eliminate the danger which may arise upon sending pure water through previously foul distribution pipes.

Water mains can be cleaned and deposits removed by several mechanical methods which have stood the test of time, and where the quality of a public water supply is about to be improved this cleaning of the mains should go hand in hand with filtration or other improvement in in the quality of the water. What boots it to advance the standard of water to a high degree and then destroy its sanitary quality by sending it to the consumer through dirty pipes? Experience has come to me in a very serious way, both in filtering the water supply of Philadelphia and otherwise, which convinces me that some of the typhoid fever vagaries from a filtered water are not chargeable in some instances to poor operation of the filters, but rather to the stirring up of old deposits in the mains which contain the necessary matter for the development of the typhoid organism in the human system. A considerable increase in the rate of flow through water mains will start these old deposits and destroy the wholesomeness of a well filtered water. The evidence of the change is manifested to the consumer by the turbidity of the previously clear water and very unfortunately sometimes by typhoid fever in his family.

The prompt removal of sewage from premises is necessary to health but in effecting this removal we should have some regard for the health of others who may become victims of our carelessness or indifference. Aside from the desire to keep our streams free from pollution they should not be used to carry sewage pollution from

*Extracts from address read before Conference of State Board of Health with Municipal Health Officials January 22-23, 1914.

one town to the water supply of another, and some remedy must be sought to guard against this evil.

It might not be out of place to here remark that some twenty years ago I entertained the thought that if all water supplies for domestic and dairy use, and any other use in connection with food or drink, were free from typhoid fever organisms that typhoid fever would soon be stricken from the list of diseases, and that water in some form or condition was responsible for our continued typhoid rates, and that with pure or purified water, universally used for dietetic purposes and in connection with articles of diet ingested even uncooked, we might hope for practically the elimination of typhoid.

It may be recalled that Prof. Dr. Von Pettenkofer leaned strongly to this theory, based largely no doubt upon his experience with the disease in Munich, after the introduction of a new public water supply from springs in the Mangfall Valley.

Various methods of sewage disposal have been tried and some permanently adopted.

Screening the coarser floating particles from sewage is a part of every system of disposal. Grit chambers to remove by limited sedimentation the heavier solids held in mechanical suspension is also a part of every system, where combined sewers are in use. But after these two steps have been taken, the further treatment takes a wide range from simple and limited sedimentation, to the most refined methods of filtration adapted to the treatment of sewage.

The treatment of sewage will depend upon the disposition of the final effluent. If the effluent is to be discharged into a rapid flowing stream of large relative volume, the degree of purification need not be so high as it should be when the dilution and opportunity for oxidation of the decomposable matters in the sewage will be less. If the sewage outfall is into a stream not drawn upon for public water supply, nor used for watering stock, and where nuisance only is to be considered, the purification need be only sufficient to avoid putrescibility. But if the stream is used below the point of sewage outfall for public water supply, or for watering stock, and the effluent must be no worse, and possibly better than the water naturally flowing in such stream, then the most advanced and comprehensive methods of purification will be necessary to meet the present sanitary requirements.

In the case of a public water supply, the standards of quality whether the water be naturally wholesome, or made so by filtration, will be about the same everywhere, so that the analytical conditions which determine wholesome water are not difficult to establish, and will not vary materially the world over. But standards for sewage effluents are not so easily established. Thus sewage discharged into New York harbor where the fresh and salt water dilution will be very large and the water nowhere used for domestic purposes, nor for the watering of stock, may be much inferior to the sewage effluent which can safely be discharged into Lake Erie at Cleveland, or of the sewage effluent which can safely be discharged into the Ohio River at Pittsburgh.

Each place may require a standard of sewage effluent different from the other places, and as a consequence the systems of sewage purification will take a wide range of design and efficiency, depending upon the place and condition of final discharge.

In Europe almost every known method of sewage disposal has been tried. Some of these methods have survived the experimental stage and have become standards under proper conditions, others have been tried and finally abandoned. At Glasgow, for example, the sewage is simply screened, the grit intercepted, a few hours of continuous sedimentation allowed, when the effluent is run into the Clyde, on the ebbtide, and the sludge pumped from the sedimentation tanks and carried out to deep water in the sea, in sludge boats constructed for the purpose. Some of the heavier sludge, however, is loaded on railway trains and then used for filling lowlands along the river below Glasgow, and some of it is pressed in order to extract part of the water, and is then dried and sold as a fertilizer. The fertilizing value of the average sewage sludge is low, and the thought once entertained by Victor Hugo and others of less romantic mind, that the elements of a complete fertilizer were to be found in domestic sewage has long since been disproved. Sewage has been successfully applied to certain kinds of crops, but it has no broad application as a general fertilizer, and when so used the crop must be adapted to the sewage. Of course, something else must be grown on the land besides "alfalfa" and "cabbage" if we are to live, and to the great crops of corn and wheat upon which the farming life of the nation depends, it is doubtful if a raw sewage can be of material benefit.

The disposal of sewage should be conducted upon strictly sanitary lines, and if processes can be worked out which will enable some portion of the sewage to yield a profit, these must have in view the sanitary end as the first object.

In this state the proper treatment and disposal of sewage is generally required to prevent pollution of our streams, and to avoid nuisance. Some of our streams, like the Cuyahoga River at Cleveland, and Millcreek in and north of Cincinnati, are now so vile from untreated sewage effluents that at times it seems that it only requires a match to set fire to them. But these conditions will soon be remedied in both places, and we may expect to see the waters of these streams flow into Lake Erie and the Ohio River respectively, as clear and sanitary as the natural waters of the Lake and River, and perhaps safer for ordinary uses.

It is a theory in one part of Germany to-day, that after the sludge has been precipitated by a few hours' sedimentation from raw sewage, that the effluent can be safely discharged into a relatively small stream, provided the stream has a good current, and no places occur in it where the unsedimented solids in the sewage can strand. That is to say, the sewage must be kept moving until it reaches a body of water large enough to furnish proper dilution. The dilution in the small streams may be low provided the current is maintained, and to this end brooks have been improved and artificial channels created, for the carriage of the sewage effluents at constant safe velocities.

The Imhoff septic tank has come into vogue in the Emscher district of Westphalia, as an adjunct of this system. In this district all the smaller streams and constructed channels flow into the Emscher River, and the river finally empties into the Rhine, where the volume of flow is relatively large.

If we pursued our plans for sewage disposal as persistently and cheerfully as do our neighbors in Europe, much better results would probably be accomplished, and less complaint would be heard from those to whom the sewage effluent of our cities is a nuisance and sometimes a menace to the public health.

The collection and proper disposal of garbage and other city wastes is another branch of sanitation that

must not be neglected. Because we cannot readily trace disease to city dumps, there is no reason why these eyesores should remain as blots on the landscape. All these dumps are more or less a nuisance, and in decency should be abated. It may cost something to collect and properly dispose of wastes and rubbish, but very little that is desirable is obtained without cost, and no expense that we indulge in will yield so large a return in the beautifying of our small streams in the unimproved outskirts of our cities as the complete abolition of our waste and rubbish dumps. No one wants a garbage or waste dump on or near his premises, but he is not so particular about someone else's premises, and that which is unsightly and an offence to his finer sensibilities will likely be a nuisance and offence to others who from locality are compelled to endure it.

In cities of less than 100,000 population it is thought that garbage and other wastes and rubbish are best disposed of by combustion in high temperature destructor furnaces, if sanitation is the object in view.

In large cities, however, the garbage can be separately collected and reduced to inoffensive and saleable products with reasonable profit and the other wastes and rubbish from domestic, commercial and municipal sources can be collected, sorted and some material of value obtained from them before the useless matters are destroyed. The picking over of garbage wastes and rubbish to obtain revenue is a doubtful procedure. Great risk is run by the "pickers" in handling cast-off clothing, bed linen and some other household articles. The picking of inorganic matter may be attended with no great risk, but all material which by chance can transmit disease should not be picked and preserved, but be promptly put through the combustion furnace and rendered harmless.

In some cities the garbage is collected and delivered to the reduction works at cost, the reduction being performed under contract by private parties, while in others the reduction as well as collection is conducted by the municipality. The net profit from the handling of the garbage in Cleveland, for the year 1909, was $85,715, and by the adoption of the same energetic and efficient methods in some of our other cities corresponding results can be expected.

Garbage when reduced will yield grease and fertilizer, but the value of the fertilizer will be low. The grease is a valuable product and this together with the articles of value "picked" from the garbage constitute the source of profit.

Small cities cannot successfully conduct garbage reduction works owing to the lack of sufficient raw materials to work upon from day to day, and in these, with sanitation as the object, the garbage and all other wastes and rubbish should be reduced to clinker, ash and gases, in high temperature "destructor" furnaces. "Picking" the garbage and wastes may furnish some material that is saleable but after this has been done, the remainder of the material should be quickly destroyed.

In suburbs of cities and in villages the rubbish and wastes from the household can often be destroyed on the premises, and when this is done the burden on the municipality will be correspondingly lessened. Organic wastes and rubbish of whatever kind should not be alowed to accumulate, and the same desire for cleanliness of person and clothing which we are all supposed to have should apply to the household, the factory and the store.

How often are we shocked at sight of dump heaps and rubbish piles along our trunk line railways in the outskirts of cities; useless in themselves, eyesores, nuisances and sometimes the cause of ill health?

The City of Cincinnati collects and reduces its garbage, but ashes, street sweepings, domestic, commercial and building wastes and rubbish are collected as daily tributes to our waste heaps or so-called "city dumps." Things that cannot be used should be destroyed, and not left to encumber the premises or the landscape, to offend good taste and obscure the face of nature.

No one should be offended by an order to clean up his premises and keep it clean, to collect and reduce, pick over or destroy what he cannot use, with the best means at his disposal, and when the individual has done all that can reasonably be expected of him then the municipality must do the rest.

PERMEABILITY OF CONCRETE.

Results of great importance to contractors, engineers and farmers who have to do with concrete construction are being obtained in a series of tests to determine the rate and the amount of flow of water through concrete. The College of Engineering of the University of Wisconsin is making these tests with the object of finding a simpler means of making concrete watertight. A large cement company in the middle west is co-operating with the college by offering the facilities of its plant.

Already some interesting results have been gotten in the effect of the length of time of mixing in a machine mixer of the batch type; the effect of the percentage of mixing upon the imperviousness of the concrete; the effect of having sand in dry condition before mixing; and the effect of having the sand wet.

The experimenters have found that good results are obtained if the concrete remains in the mixer from two to three minutes when dry materials are employed. For cases where the sand and gravel or stone are damp a considerably longer time is required. Therefore the use of wet sand should be avoided if possible. The experiments showed that mixtures consisting of 1 part of cement, 1½ parts of Janesville sand of the Torpedo grade, and 3 parts of Janesville gravel, when mixed to a wet consistency, are impervious to water when subjected to a pressure of 40 pounds per square inch. Mixtures as lean as 1 part of cement to 6 parts of gravel (a graded mixture) have been made impervious at high pressures by using care in proportioning the amount of water and in mixing the batch. The specimens used in making these tests are cylindrical in form and so made that the faces of the cylinders, which are 13½ inches in diameter, are exposed to the predetermined water pressure. The thickness of the concrete through which the water must pass can be varied from 4 to 18 inches. Ample provision is made for cleaning both faces of the cylinder before placing it upon the testing apparatus. The apparatus itself is so arranged that very accurate tests can be made.

The importance of these experiments will be more sufficiently appreciated when it is understood that a large proportion of the trouble arising from poor concrete is due to the use of defective sand or gravel.

The department is also studying the effect of varying the percentages of cement and water, the gradation of the sand and gravel (by this is meant the size of the rocks and the fineness of the sand), the proportioning of the mixture, the thoroughness of mixing, and the effects of different conditions on the hardening of the specimens.

LOSS OF HEAD DUE TO BENDS IN WATER PIPES.

THERE has been much argument as to the loss of head due to bends or curves in pipe lines. Many theories have been advanced and many attempts to determine the laws which govern it have been made, but after great care, different experimenters have arrived at quite different conclusions. The result is an abundance of experimental data on the subject with small means of determining what are most feasible and most reliable.

A good deal of accurate information, derived from the data already at hand, is contained in a paper on the subject by Mr. W. E. Fuller, read by him before the New England Waterworks Association last September. It is in such a form as to admit of ready determination of the probable loss of head in bends and curves under the conditions that are ordinarily met with in waterworks practice.

It is known that water passing around curves and bends loses a greater amount of head than when passing through an equal length of straight pipe. When the direction of the flow of water is changed, the distribution of velocity and pressures in the pipe is also changed, eddies are set up, and probably other actions take place which cause this excess loss.

It is more convenient, in comparing different bends, to divide the total loss of head due to the bend into two parts: (1) that which occurs in an equal length of straight pipe; (2) the excess loss due to the curve. If this is done it is necessary to assume that the effect of roughness of pipe, condition of joints, and other matters which affect the flow in straight pipe have the same effect on the flow in curved pipes. Quite probably this is not exactly true, in which case bends of the same dimensions with different hydraulic conditions would give different excess losses of head. The experimental data are insufficient to decide this matter, but they indicate that the effect of roughness, etc., is not greatly different in the two cases. Loss of head due to bends will be considered as that portion of the total loss in excess of the loss which would occur in an equal length of straight pipe.

It is known that the disturbance caused by the bend is continued for some distance in the straight pipe beyond the bend and that the loss due to the bend continues in this straight pipe. It is also probable that the pipe preceding the bend, causing more or less eddies, according to its condition, may affect the loss due to the bend. The fact that some of the loss due to the bend takes place in the straight pipe makes it necessary in experimental work to measure the head at some distance beyond the bend itself. The loss due to pipe friction must then be eliminated before the loss due to the bend can be obtained. This pipe friction represents a large proportion of the total loss, so that errors in obtaining it materially affect the loss due to the curve. With all these difficulties to overcome it is not surprising that the different experiments should not agree closely.

Main Points at Issue.—For practical purposes it is essential to know the effect of both the radius of the bend and the velocity upon the loss of head for pipes of different sizes.

Until recent years Weisbach's formula, based upon experiments made on small pipes, was generally accepted. This formula is:

h_b (additional loss of head due to 90° bend) = 0.13

$$+ 1.85 \frac{D}{2r} \cdot \frac{v^2}{2g},$$

in which D is diameter of pipe, r the radius of the centre line of the bend, and v the average velocity in the pipe. On this basis the greatest loss of head would be from a bend of the smallest radius, and the longer the radius the less the loss would be.

Experiments made at Detroit on pipes of 12, 16, and 30 in. in diameter, indicated losses quite different from those given by the Weisbach formula. From these experiments it was concluded that the loss of head was a minimum for bends with radii of about two and one-half times the diameter of the pipe. These experiments also indicated that the loss did not in all cases vary as the square of the velocity.

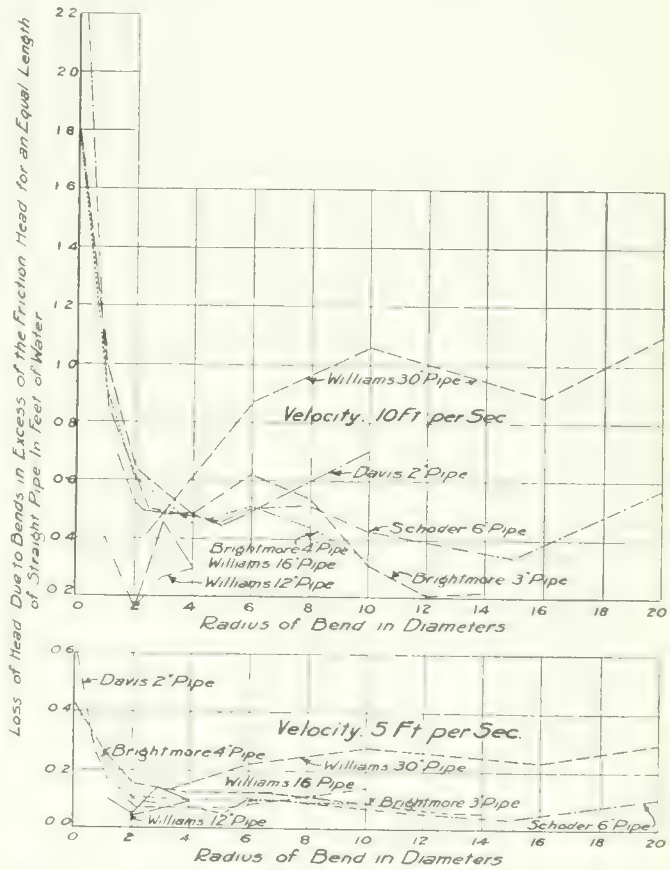

Fig. 1.—Loss of Head Due to 90° Bends. Radius in Diameters.

Further experiments made on 2, 3, 4 and 6-in. pipe showed that the Weisbach formula did not hold for larger pipes under ordinary conditions of service. These later experiments, however, did not confirm the Detroit experiments as to the minimum loss occurring with bends of a radius of 2½ pipe diameters. These different experiments indicated quite different variations of loss in relation to the velocity. Some of the experiments showed this relation as high as $v^{2.75}$, while others showed it as low as $v^{1.5}$.

These experiments give the best basis that we have of obtaining the loss of head in bends.

The experiments were all carefully made, every effort being made to eliminate errors. The conditions existing for the different experiments were nea enough alike to justify the expectation of at least an approximate agreement.

In the discussion of the question resulting from these experiments it seems to have been assumed that the loss of head in bends on different sizes of pipe should be the same when the radius of the bend in terms of the di-

ameter of the pipe were alike. The writer sees no valid reason why this should be so. With so many different factors contributing to the loss there seems no reason to assume such a relation. If this assumption is abandoned, a much closer agreement between the data can be obtained and it seems better to accept the experiments as they stand, adjusting the conclusions to the data rather than to assume that some of the data are in error simply because they do not satisfy the above assumption.

Effect of the Radius.—A study of the data shows that the loss is more nearly the same for different sizes of pipes with bends of the same actual radius in feet than for bends of the same radius in pipe diameters. This is shown by a comparison of Figs. 1 and 2.

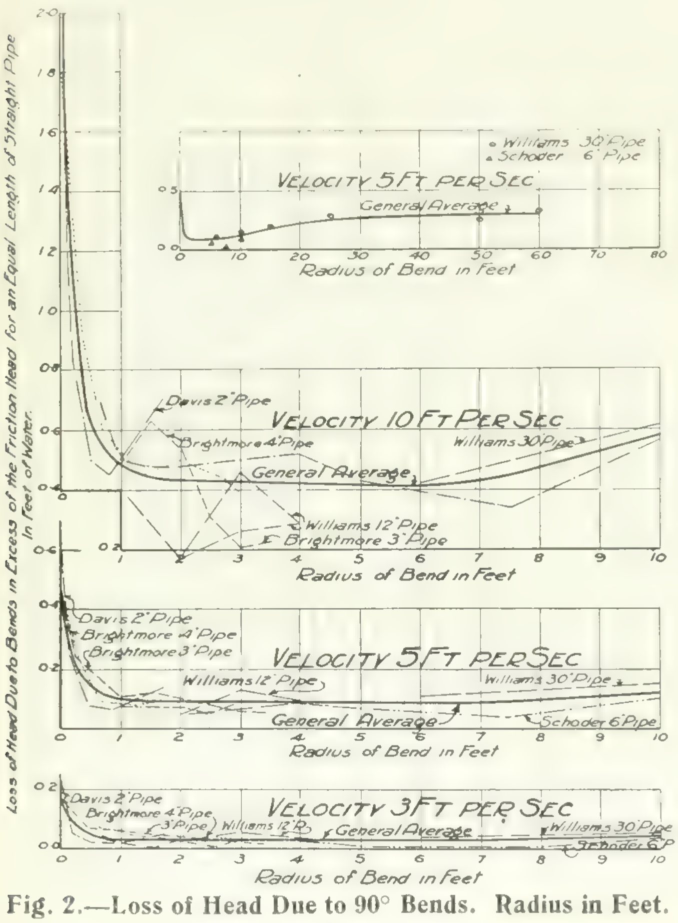

Fig. 2.—Loss of Head Due to 90° Bends. Radius in Feet.

Fig. 1 shows a plotting of the data on the basis of the radius in pipe diameters, while Fig. 2 shows a similar plotting on the basis of the radius in feet. On Fig. 1, while the curves representing the losses in bends of diameters from 2 in. to 6 in. agree fairly closely, those for the larger pipes are very different. On Fig. 2 a much closer agreement between the small and large pipe curves is obtained.

It is probable that neither of these diagrams is on the correct basis, and that the actual relation between the loss of head and the radius is a more involved one. Possibly the inner radius or the outer radius of the bend should be used for the comparison instead of the radius of the centre line; or it may be that both r and D are involved in some more complicated form.

On Fig. 2 the average curves drawn fit the data approximately and may be used for obtaining the probable loss of head in bends.

Relation of Loss of Head to Velocity.—Values of the loss of head for different velocities due to bends of the same radius, taken from the average curves on Fig. 2, were plotted on logarithmic paper in relation to velocity. From these plottings the relation was established that the loss of head is proportional to $v^{2.25}$. On this that the loss of head is proportional to $v^{2.25}$. On this basis a formula for loss of head may be stated as $h_b = kv^{2.25}$, in which k is a coefficient different for bends of different radii, and h_b is the loss of head in excess of the loss in a straight pipe of a length equal to the length of the curve. On Fig. 3 is given the values of k for bends of radii up to 60 ft. This relation between h_b and v is an average relation, as indicated by the experiments used. Further experiments may change it materially.

Practical Use of the Data.—Fig. 2 gives the loss of head due to 90 degree bends in excess of the loss due to friction in straight pipe of a length equal to the length of the curve. To compare the total loss of head which would actually occur in pipe lines containing these curves, it is necessary to take into account the relative length of the different curves. The use of long curves makes the total length of pipe less than the use of short curves giving a corresponding smaller loss in pipe friction.

The introduction of this matter brings in a difficulty in that the friction will vary as the roughness of the pipe, so that the curve giving the least total resistance for one pipe will not do so for another pipe with different

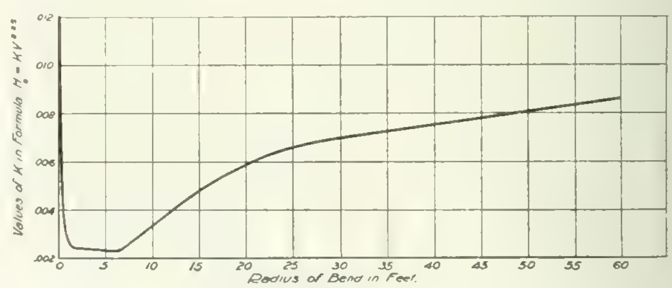

Fig. 3.—Values of "K."

hydraulic conditions. It is most convenient to compute the loss of head in pipe lines by taking the actual lengths of the tangents as straight pipe, finding the frictional resistance in it, and then adding the excess resistance due to curves and other specials.

To meet this requirement Fig. 4 has been drawn, on which is shown the excess loss of head in bends over what would occur in straight pipe of a length equal to the tangents of the curve under average conditions. The data for plotting this diagram were obtained as follows: The loss due to the curve is taken from the average curve in Fig. 2. The friction in straight pipe of a length equal to the difference between the length of the tangents and the length of the curve is then deduced. The frictional resistance in straight pipe is taken according to the Hazen-Williams formula with $c = 100$. The coefficient represents the average pipe after it has been in use for some years. As the loss of head in bends becomes of most importance at the time when the pipe is being used at its maximum capacity, which usually comes aften some years of use, this value of c will probably meet the usual requirements. For new pipe well laid this excess loss in head would be somewhat greater, while for pipe in very bad condition it would be less.

Fig. 4 shows the following interesting points:

1. The excess loss of head in bends is greater for large pipes than for small ones.

2. For large pipes a six-foot radius bend gives the least resistance, unless very long radii are used.

3. If the radius can be made very long, the least resistance will evidently be from the bend of greatest radius.

4. For small pipes, at least, with long radii the loss of head will be less than it would be in straight pipe of a length equal to the tangents of the curve. This occurs when the saving in friction head due to shorter line becomes greater than the excess loss due to the bend.

In order to show the loss of head for bends in ordinary use, Table I. has been prepared on the same basis as Fig. 4, giving the excess loss for bends made according to the New England Waterworks Association standard.

Table I.—Loss of Head Due to Ninety Degree Bends of the New England Waterworks Association Standard.

Size of pipe. Inches.	Radius bend. Feet.	Excess loss over loss in straight pipe of length equal to tangents. $v = 3$ ft.	$v = 5$ ft.	$v = 10$ ft.
4	1.33	0.021	0.073	0.37
6	1.33	0.025	0.082	0.40
8	1.33	0.026	0.086	0.41
10	1.33	0.027	0.089	0.42
12	1.33	0.028	0.090	0.43
16	2.0	0.026	0.085	0.41
20	2.0	0.027	0.086	0.41
24	2.5	0.026	0.085	0.41
30	3.0	0.026	0.083	0.41
36	4.0	0.026	0.083	0.40

Necessity for Considering Loss in Bends.—For most lines of small pipe, consideration of economy or convenience in laying will govern the selection of the bend or curve to use. Generally, of course, the use of very sharp bends should be avoided. In designing pipe systems about pumping stations, filter plants, and elsewhere, where many specials are necessary, a thorough understanding of the loss is important to avoid unnecessary loss of head.

For large pipes the losses in bends assume a far greater importance. The loss is more important for several reasons. First, the actual loss is greater for the larger pipes than for small pipes. Second, for the same velocity the frictional loss is less for large pipe than for small pipe, so that the loss in bends is a greater proportion of the total loss. Third, the amount of money involved is greater in the case of large pipe, and a greater expenditure is justified to avoid losses of head.

The importance of losses of head which occur on large pipe lines at bends and at other specials and at entrances and outlets of the pipe to structures is not as generally realized as it should be. It is not uncommon to find losses from such causes, in large and comparatively short pipe lines, a large percentage of the total loss. In many cases much greater capacity of the line could have been obtained by proper consideration of the losses in the design of these works, and in some cases the capacity could have been nearly if not quite doubled. Instances of this may be found in intake and suction pipes. The importance of these losses may be understood when it is realized that in 1,000 ft. of 72-in. pipe a single 90° bend poorly designed may readily reduce the capacity of the line by 5 per cent., and a poorly designed inlet or outlet of the pipe to a structure may reduce the capacity by fully 10 per cent. It is not uncommon to find structures on pipe lines in which the velocity is suddenly reduced to a small amount, after which it is again increased. Such structures are extremely wasteful in head. A careful design to secure gradual changes in velocity and to prevent eddies at specials is very essential in order to secure the proper capacity of large lines and to prevent the waste of capital in building larger pipe lines than are needed.

Loss of Head in Other Than 90° Bends.—There are but little data on losses in curves of radii other than 90° curves. Even with bends of small curvature the flow is disturbed, eddies are started, and considerable loss of head may result. It seems certain that the loss in 45° bends is greater than one-half that in 90° bends. Until more information is obtained, the writer suggests the use of the following values for losses of head:

For loss of head due to 45° bends, use three-fourths that due to 90° bends of the same radius.

For loss of head due to 22.5° bends, use one-half that due to 90° bends of the same radius.

For loss of head due to a Y-branch, use three-fourths that due to a tee.

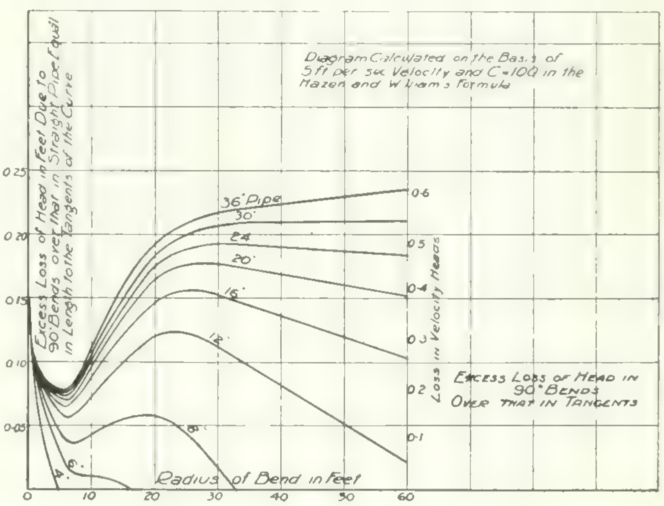

Fig. 4.

Approximate Rules for Losses of Head.—The loss of head in bends, for ordinary velocities, that is, from 3 to 6 ft., is approximately proportional to the velocity head, $\frac{v^2}{2g}$. It is convenient to express the loss in this way, and for rough approximations the following rules will serve:

For 90° bends of a radius in excess of 1.5 ft. and less than 10 ft., $h_b = \frac{1}{4}\frac{v^2}{2g}$.

For tees (bends of zero radii), $h_b = 1\frac{1}{4}\frac{v^2}{2g}$.

For sharp 90° bends of 6-in. radii, $h_b = \frac{1}{2}\frac{v^2}{2g}$.

Only further experimental work can satisfactorily settle some points involved in the loss of head in bends. Experiments which would add to the data on the loss of head in bends of large diameter would prove of the greatest service. It is for such bends that the matter is of the greater importance and the data more limited.

Messrs. Cammell, Laird and Company, of Birkenhead, England, have supplied the turbines for the Canadian Pacific steamer St. George, the installation being made at the Robins drydock at New York under the superintendence of engineers from Birkenhead.

CANADIAN PRODUCTION OF PETROLEUM AND NATURAL GAS, 1913.

THE Division of Mineral Resources and Statistics of the Department of Mines, Canada, reports that the production of crude petroleum in Canada was confined during 1913 to the old established fields in Ontario with a few barrels pumped from gas wells in New Brunswick.

The annual output has been steadily declining during the past six years and shows a further falling off in quantity produced in 1913 although owing to the higher price obtained for oil a larger total value is shown than for 1912.

A bounty of one and a half cents per Imperial gallon is paid upon the production of crude petroleum, the Bounty Act being administered and payments made by the Department of Trade and Commerce. According to the records of this Department the total output of petroleum in 1913 was 228,080 barrels or 7,982,798 gallons on which a bounty of $119,741.97 was paid. The total value of the production at the average price for the year $1.782 per barrel was $406,439.

The production in 1912 was 243,336 barrels or 8,516,762 gallons valued at $345,050 or an average value of $1.418 per barrel.

The average price per barrel at Petrolia during 1913 increased from a minimum on January 1 of $1.65 to $1.75 on April 16, $1.84 on November 6, and $1.89 on December 22.

The production in Ontario by districts as furnished by the Supervisor of petroleum bounties was in 1913 as follows, in barrels: Lambton, 155,747; Tilbury, 26,824; Bothwell, 34,349; Dutton, 4,610; Onondaga, 4,172, and Belle River, 464, or a total of 226,166 barrels. In 1912 the production by districts was: Lambton, 150,272; Tilbury, 44,727; Bothwell, 34,486; Dutton, 4,335, and Onondaga, 7,115, or a total of 240,935 barrels.

The production in New Brunswick in 1913 was 2,111 barrels as against 2,679 barrels in 1912 and 2,461 barrels in 1911.

Exports entered as crude mineral oil in 1913 were 3,650 gallons valued at $379 and refined oil 24,273 gallons valued at $3,188. There was also an export of naphtha and gasoline of 17,875 gallons valued at $4,284.

The total value of the imports of petroleum and petroleum products in 1913 was $13,339,326 as against a value of $11,978,053 in 1912. The imports have been increasing rapidly during the past few years.

Crude oil is being extensively used as a fuel on the Pacific Coast in both steamships and locomotives and the wide use of the gasoline motor has created a big demand for gasoline. The total imports of petroleum oils, crude and refined in 1913 were 222,779,293 gallons valued at $13,230,429 in addition to 1,628,837 pounds of wax and candles valued at $108,897. The oil imports included crude oil 162,062,201 gallons, valued at $5,250,835; refined and illuminating oils 19,393,627 gallons, valued at $1,386,440; gasoline 29,525,170 gallons, valued at $4,822,941; lubricating oils 6,789,451 gallons, valued at $1,172,986, and other petroleum products 5,008,844 gallons, valued at $597,227.

The total imports [illegible] were [illegible] gallons of petroleum oils, crude and refined, valued at $11,858,533, in addition to 2,144,006 pounds of paraffin wax and candles valued at $119,520. The oil imports included: Crude oil, 120,082,405 gallons, valued at $3,996,842; refined and illuminating oils, 14,748,218 gallons, valued at $1,012,735; gasoline, 40,904,598 gallons, valued at $5,347,767; lubricating oils, 6,763,800 gallons, valued at $1,077,712, and other petroleum products, 4,288,463 gallons, valued at $423,477.

There was an increased importation in 1913 of all classes of oil with the exception of gasoline, the increases being most pronounced in crude oil and refined illuminating oil.

Natural Gas.—There was comparatively little change in the production of natural gas in Ontario but a large increase in the production in New Brunswick and in Alberta. The total production in 1913 was approximately 20,345 million feet valued at $3,338,314, of which 828 million feet valued at $174,006 was from New Brunswick; 12,487 million feet valued at $2,092,400 from Ontario, and 7,030 million feet valued at $1,071,908 from Alberta.

The production in 1912 was reported as 15,287 million feet, valued at $2,362,700, and included 174 million feet from New Brunswick, valued at $36,549; 12,529 million feet from Ontario, valued at $2,036,245, and 2,584 million feet from Alberta, valued at $289,906.

These values represent as closely as can be ascertained the value received by the owners or operators of the wells for gas produced and sold or used. The values do not represent what consumers have to pay since in cases where transmission is by separately operated pipe line companies such cost is not included.

It has been finally decided by the State of New York to request the foreign relations committee of the House of Representatives to recommend that New York State be vested with power to permit the diversion of water from Niagara River for power purposes or to establish a State power plant at Niagara Falls.

The Wheeler Condenser and Engineering Company, of Carteret, N.J., have opened an office at 122 Board of Trade Building, Montreal, under the management of Jos. McKay, Jr., formerly New York manager of the company. The company make surface and jet steam condensers water-cooling towers, feed-water heaters, evaporating apparatus, etc.

One of the most interesting railway structures in the world is the bridge over the Faux Namti gorge in Indo-China, where, owing to the peculiar difficulties in the way of building a bridge of any type, it was necessary to adopt a special design suited to the only method of erection that seemed possible. The sides of the gorge are practically vertical; and there is no approach to the bridge from either side except through tunnels. The track grade is 335 feet above the river, so that no system of falsework could be used in building the bridge, while cantilevers were out of the question owing to the lack of "elbow-room." The design finally adopted consisted of two steel trusses, each hinged at the cliff side, which were erected in a vertical position and then lowered so that the ends met, forming a structure of inverted V-shape. The ends of the two trusses were firmly connected; steel towers were erected on the humps of the trusses; and, on this support, the steel deck truss, carrying the track, was placed. At the beginning of the work it was necessary to let the workmen down by ropes from the tunnel mouth to prepare the foundations of the supporting trusses. The track trusses were built in the tunnels and were then moved into position on rollers. From end to end this bridge measures 220 feet 4 inches, while the distance between the heels of the supporting trusses is 180½ feet.

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SPECIAL BOARD FOR LAKE OF THE WOODS QUESTION.

One of the Privy Council committee reports approved on March 2nd by the Governor-General, deals with the organization of a Board, representative of different departments of the Government, for the special consideration of various questions that are being referred from time to time to the International Joint Commission. Questions frequently arise in which more than one department of the Government is interested and in regard to which several departments have special knowledge. In order that such questions may be fully and effectively dealt with, it has been deemed desirable that there should be some method by which advantage may be taken of the information possessed by the different departments, and thus greater co-operation secured in dealing with the problems involved.

It is interesting to note that in the United States such matters are within the jurisdiction of, and dealt with by, the War Department alone.

At the present time the question which requires the most urgent consideration is the one involved in the reference regarding the level of the Lake of the Woods, and it is suggested that a Board be organized for the special purpose of considering it, and outlining a policy for submission to the Government.

The report recommends that the working members of the Lake of the Woods Board should be representatives of the various departments affected. The Department of Marine and Fisheries and the Department of Public Works are responsible for the navigation on the lakes; the Fisheries Branch of the Department of Marine and Fisheries is interested in the propagation and care of fish and, therefore, in any change of level which may affect the spawning beds; the Department of the Interior is much interested in the water powers connected with the watershed of the Lake of the Woods, particularly those in the Province of Manitoba; the Hydro-Electric Power Commission of Ontario is interested in the water powers in the Ontario section of the watershed; and the Department of the Naval Service is charged with the work of preparing charts for navigable waters.

In view of difficulties that may be encountered in getting representatives from these various departments to act together, and in order to facilitate direct communication with the Government, it is suggested that a member of the Cabinet should be the chairman of the Board. The report accordingly recommends the constitution and appointment of such a Board under the chairmanship of the Minister of Marine and Fisheries, to consist of the following members as representing their respective departments: B. H. Fraser, assistant chief engineer, Department of Marine and Fisheries; S. J. Chapleau, district engineer, Department of Public Works; J. B. Challies, superintendent, Water Power Branch, Department of the Interior; W. J. Stewart, chief hydrographer, Department of the Naval Service and External Affairs; and H. G. Acres, hydraulic engineer, Hydro-Electric Power Commission of Ontario.

The committee also recommend that the Board be instructed to examine the various departmental interests involved, bring them into harmony as far as possible, and present to the International Joint Commission the views of the Government of Canada on this question.

Authority should be given to the Board to appoint the requisite number of clerks, or junior engineers to collect and tabulate such data as may be collected; and further (with the concurrence of the Prime Minister), that

the necessary expenses in connection with the carrying out of these proposals be defrayed from the contingencies of the Department of External Affairs.

MUNICIPAL ENGINEERS AND PRIVATE PRACTICE.

An Association of Consulting Engineers was recently formed in Great Britain. At the inaugural dinner it was strongly pointed out that there was a necessity for the new departure. In order to maintain a profession at its highest level it was essential that it should have an external conscience, in addition to the individual conscience of its members, and the new society was due to have a conscience of this kind. It would draw a distinct line between the municipal engineer as he should be, and the municipal engineer when he becomes commercialized and competes with private enterprise.

One of the strong advocates for the association, Mr. J. H. Balfour-Browne, K.C., felt very keenly against the State and municipal engineers being permitted to compete with consulting engineers. They should devote all their time and attention to the work of the municipality, and be adequately paid for doing this duty. If they did devote their time and attention adequately to the work of the municipality, they ought to have no time for engaging in private practice. Apart from this, there was the danger in a municipal engineer acting in a consulting capacity, that he was liable to have a narrow outlook. The variety of the work engaged in by the consulting engineer was his strength, and was apt to give a judicious breath to his decisions, which was invaluable to his client. The Association of Consulting Engineers was doing good work, both for itself and for the public, in keeping up the standard of the profession.

These grounds for the preclusion of State and municipal engineers from acting privately in a consulting capacity are, according to the London *Times*, thin and unconvincing. "For," says the *Times*, "if variety of experience is a source of strength to the everyday consulting engineer it is reasonable to suppose that the municipal engineer would also acquire strength and develop the judicial attitude of mind from occasional indulgence in that class of work. The truth is that the most weighty objections to the acceptance by qualified engineers of private consulting work are based not upon their lack of knowledge, experience, of powers of judgment, but upon ordinary considerations of what is expedient for public servants. In this respect members of the engineering profession holding State or municipal appointments are even more restricted than members of the legal profession in like circumstances. The essential requirement in private consulting work is that when advice is sought upon an engineering matter the engineer selected should be a qualified specialist upon the subject in question; and what the public have to avoid is the employment of a person who poses as a consulting engineer upon every engineering subject that presents itself. In cases of doubt regarding qualifications, an appeal can always be made to the councils of the great engineering societies and institutions."

Some difficulty was encountered during the formation of the new association in discovering exactly what the term "consulting engineer" constituted, as applied in England. The definition proved hard to deduce, although of considerable import, as the association rules are to be applicable only to consulting engineers—professional men to work along professional lines and to advise clients to the best of their ability irrespective of their own pockets.

SURFACE INSULATION OF PIPES.

An investigation of the subject of surface insulation of pipes as a means of preventing damage to underground metallic structures by stray currents from electric railways has recently been completed by the U.S. Bureau of Standards, by Burton McCollum and O. S. Peters. Tests were made of the various substances available for the purpose of insulation of underground structures, including paints, pitch and asphalt dips, pitch and paper and asphalt and felt wrappings, and so forth. Test specimens were made by lining shallow sheet-iron cones with the material to be tested. Before being subjected to the final test each cone was filled nearly full of ten per cent. salt (NaCl) solution and an alternating difference of potential of 80 volts (effective) applied across the coating for 30 seconds, in order to be sure that it was continuous and without flaws. A milliammeter in series with the specimen indicated a defective coating by a kick of the needle. The electrical resistances of the perfect specimens were then approximately determined with a Wheatstone bridge. In the case of the paints these resistances were found to be of the orders of from 10^8 to 10^{11} ohms per square centimetre, while for the wrappings they were much higher.

The final test of the specimens which survived the preliminary test consisted in allowing water and air alternately to come in contact with the coating while a direct potential difference of either four or fifteen volts was applied across the coating. The value of the voltage applied depended on the thickness and other characteristics of the coating. In some of the specimens made up from each material the iron of the cone was made negative and in others positive, while in the case of the paints some of the specimens were subjected to the alternate action of air and water with no potential difference applied, in order to check up the effect of the electric stress.

The alternating contact with the coating of air and water was obtained by filling the cone and allowing the water to evaporate, which took about a week. Readings of the current flow were made at suitable intervals. The first appearance of current flow was taken as indicating the end of the useful life of the specimen as an insulating coating.

The average life of the paints was about 116 days, the maximum life obtained from any specimen being but little more than a year. No conclusive evidence was obtained that the low potential differences applied had any effect in hastening the initial failure of the coatings. The wrappings lasted longer than the paints and dips, but none of them much more than 400 days. It seems from the results that the failure of the coatings must be caused by absorption by them of water, which in time penetrates to the iron, allowing current to flow and destroy the coating by electrolysis. After the first appearance of current flow the destruction of the coating was observed to proceed very rapidly.

The conclusion drawn from the results of the laboratory tests, as recently published in Technologic Paper No. 15, of the Bureau, to the effect that the protection against electrolysis which is obtained by wrapping or painting pipes or other metallic bodies for use underground is only temporary, is borne out by tests on insulated pipes buried in the ground under practical conditions, and also by correspondence with gas and water companies whose experiences lead to the same conclusion.

LETTER TO THE EDITOR.

Cost of the National Transcontinental Railway.

Sir,—I notice in the daily press, under the heading of "Bonded Indebtedness and Annual Interest Charges of Canadian Roads," an item for the National Transcontinental Railway as follows:—

"Line, Moncton to Winnipeg, being constructed by Dominion Government

"Estimated cost guaranteed by Dominion Government, $234,000,000."

The cost of the National Transcontinental Railway for constructing and equipping the road, outside of rolling stock, from Moncton to Winnipeg, will not far exceed $150,000,000. Major R. W. Leonard, Commissioner, and Mr. Gordon Grant, Chief Engineer, estimate this cost to be somewhere around $150,000,000. An item appeared in another Montreal paper as follows:—

"Ottawa, February 19.—The National Transcontinental Railway and its cost is dealt with in an interim report of the Commissioner, Major Leonard, for the nine months of the fiscal year ended December 31. It was tabled in the House last night.

"The total outlay in the nine months was $10,314,994, and up to the end of the calendar year the aggregate was $140,567,147. This is exclusive of interest on capital.

"Track-laying was completed on the eastern section on November 17. There are 1,803 miles of main line, 20 of double track, and 407 of sidings. Steel bridges are 95 per cent. completed.

"The rest of the report deals with contracts awarded during the year for buildings, equipment and supplies."

This proves that my statement is correct, as any competent railway engineer knows that it should not take more than $10,000,000 to $20,000,000 to complete the road, ready to operate in an efficient manner. Any engineer connected with the Headquarters Staff of the National Transcontinental Railway at Ottawa, will affirm that the cost of construction of this road will not be over $160,000,000, and that according to the National Transcontinental Act, the Grand Trunk Pacific will only have to pay interest on the actual cost of the road, which will not exceed $160,000,000.

My reason for drawing your attention to this matter is that I don't think it fair to the credit of Canada and the engineers who were connected with the National Transcontinental Railway, to advertise, not only in Canada but in Europe, that the Grand Trunk Pacific will have to pay interest on the amount of $234,000,000 when the cost of the road will not exceed $160,000,000. The cost is divided approximately as follows:—

Grading	$105,000,000
Bridges	10,000,000
Shops and terminals	10,000,000
Engine houses, stations and other buildings	10,000,000
Salaries, wages and administration expenses	10,000,000
Other items	10,000,000
	$155,000,000

Yours truly,

H. Victor Brayley, A.M.Can.Soc.C.E.

Montreal, Que., March 5th, 1914.

A METHOD OF DETERMINING THE AREA OF CROSS-SECTIONS.

By C. D. Norton,

In the computation of earthwork quantities, the most troublesome detail is the finding of the area of the various cross-sections. On railway construction a 3-level section is generally used, the area of which is found by the following well-known rule:—

Multiply the extreme horizontal width by ½ the centre height, also multiply ¼ the width of the roadway by the sum of the 2 side depths; the sum of the two products is the area required.

If, however, the cross-section contains 4 or more readings, the figure cannot always be divided into soluble triangles, and its area is best found by the following method, which has the advantage that the only figures used, are those recorded in the field book, reducing thereby the chances of error to a minimum. It is also simple and easily checked.

Cross-sections are almost invariably obtained by measuring horizontal distances and vertical elevations, each angular change being noted by a fraction, in which the numerator is a vertical elevation, and the denominator a horizontal distance. As these measurements refer to a base line and a datum at right angles to it, they can be correctly termed *rectangular co-ordinates*.

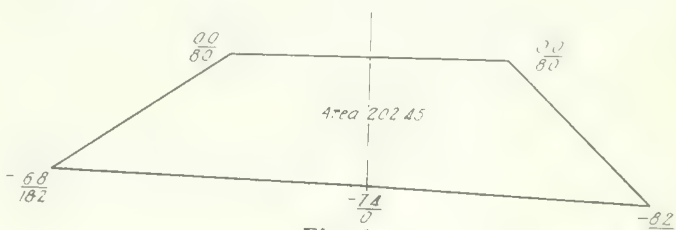


Fig. 1.

A rule to find the area of a figure platted by rectangular co-ordinates can be formulated as follows:—Designate the vertical ordinates as numerators, those above the point of origin being plus, and those below being minus; designate the horizontal ordinates as denominators, those to the right being plus and those to the left, minus. Multiply each numerator by the algebraic difference of alternate denominators. One-half the del. sum of the products will be the area required. If the measurements are taken in feet the result will be in square feet, if in metres the result will be in square metres. The terms may be taken clockwise or not, as may be desired, but in either case a regular order must be observed from start to finish, and strict attention given to the algebraic signs.

To apply the foregoing to earth cross-sections the rule can be worded as follows: Designate cuts and distances to the right as plus, fills and distances to the left as minus. Multiply each numerator by the algebraic difference of alternate denominators, one-half the del. sum of the products will be the area of the figure.

As it is often necessary that calculations be made by men whose knowledge of mathematics is limited the rule can be best understood by following a series of examples.

Example I. (Fig. 1).

Fills.	Alternate Distances.		Differences.	Products.
—6.8	—8.0	0.0	—8.0	54.4
—7.4	—18.2	20.3	—38.5	284.9
—8.2	0.0	8.0	—8.0	65.6
				404.9

One-half of 404.9 = 202.45 = Area.

Distances.	Alternate Fills.		Differences.	Products.
— 8.0	0.0	—6.8	6.8	— 54.4
—18.2	0.0	—7.4	7.4	—134.68
0.0	0.8	—8.2	1.4	
20.3	—7.4	0.0	—7.4	—150.22
8.0	—8.2	0.0	—8.2	— 65.6
One half of 404.90 = 202.45 = Area.				—404.90

It will be noticed that there are two solutions to each figure, one in which the numerators are multiplied by alternate denominators, and one in which the denominators are multiplied by alternate numerators, the result in each case being the same, although the figures in the products are dissimilar. In example No. I. it will be noticed also that the figures resolve themselves into the rule for 3-level sections.

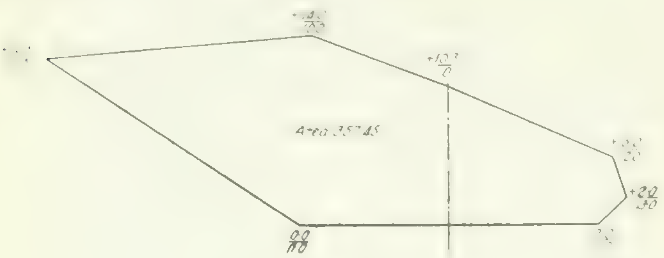


Fig. 2.

Example II. (Fig. 2).

Cuts.	Alternate Distances.		Differences.	Products.
14.0	0.0	—29.5	29.5	413.0
12.3	—10.0	—11.0	1.0	12.3
0.0	—29.5	11.0	—40.5	
0.0	—11.0	13.0	—24.0	
2.0	11.0	12.0	— 1.0	—2.0
5.0	13.0	0.0	13.0	65.0
10.3	12.0	—10.0	22.0	226.6
				716.9
				—2.0
One-half of 714.9 = 357.45 = Area.				714.9

Distances.	Alternate Fills.		Differences.	Products
—10.0	10.3	12.3	—2.0	20.0
—29.5	14.0	0.0	14.0	—413.0
—11.0	12.3	0.0	12.3	—135.3
11.0	0.0	2.0	—2.0	—22.0
13.0	0.0	5.0	—5.0	—65.0
12.0	2.0	10.3	—8.3	—99.6
				—734.9
				20.0
Hence area = 357.45.				714.9

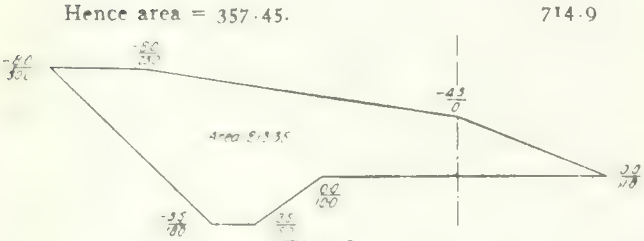


Fig. 3.

Example III. (Fig. 3).

Elevations.	Alternate Distances.		Algb. Diff.	Products.
8.0	0.0	—30.0	30.0	240.0
8.0	—23.0	—18.0	— 5.0	—40.0
—3.5	—30.0	—15.0	—15.0	52.5
—3.5	—18.0	—10.0	— 8.0	28.0
0.0	—15.0	11.0	—26.0	
0.0	—10.0	0.0	—10.0	
4.3	11.0	—23.0	34.0	146.2
				466.7
				40.0
∴ Area = 213.35.				426.7

Distances.	Alternate Elevations.		Algb. Diff.	Products.
—23.0	4.3	+8.0	—3.7	85.1
—30.0	8.0	—3.5	11.5	—345.0
—18.0	8.0	—3.5	11.5	—207.0
—15.0	—3.5	0.0	—3.5	52.5
—10.0	—3.5	0.0	—3.5	35.0
11.0	0.0	4.3	—4.3	47.3
0.0	0.0	+8.0		
				—599.3
				172.6
∴ Area = 213.35.				—426.7

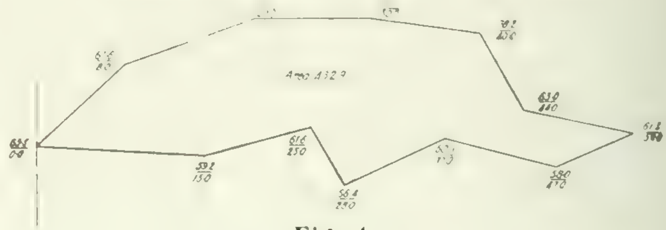


Fig. 4.

Example IV. (Fig. 4).

Numerators.	Alternate Denominators.		Algb. Diff.	Products.
13.5	15.0	8.0	7.0	94.5
17.6	0.0	20.0	—20.0	—352.0
21.5	8.0	30.0	—22.0	—473.0
21.5	20.0	40.0	—20.0	—430.0
20.2	30.0	44.0	—14.0	—282.8
13.0	40.0	54.0	—14.0	—182.0
11.2	44.0	47.0	— 3.0	— 33.6
8.0	54.0	37.0	17.0	136.0
10.5	47.0	28.0	19.0	199.5
6.4	37.0	25.0	12.0	76.8
11.6	28.0	15.0	13.0	150.8
9.2	25.0	0.0	25.0	230.0
				—1753.4
				887.6
∴ Area = 432.9.				865.8

Denominators.	Alternate Numerators.		Algb. Diff.	Products.
0.0	59.2	67.6	—8.4	
8.0	63.5	71.5	—8.0	—64.0
20.0	67.6	71.5	—3.9	—78.0
30.0	71.5	70.2	1.3	39.0
40.0	71.5	63.0	8.5	340.0
44.0	70.2	61.2	9.0	396.0
54.0	63.0	58.0	5.0	270.0
47.0	61.2	60.5	.7	32.9
37.0	58.0	56.4	1.6	59.2
28.0	60.5	61.6	—1.1	—30.8
25.0	56.4	59.2	—2.8	—70.0
15.0	61.6	63.5	—1.9	—28.5
				1137.1
				271.3
∴ Area = 432.9.				865.8

This method is noted in some text books, but is not in general use, mainly because the procedure is at first a little difficult, but with the aid of the above examples it can be easily understood.

A full mathematical discussion will be found in a book entitled "Traverse Tables," by Messrs. Louis and Gaunt, where the method is applied to the finding of areas of figures platted by Latitudes and Departures.

No less than 40,000 horsepower will be available from the new power site reserve in Boulder Canon, two miles east of Las Vegas, Nev., which the United States Federal Government has approved.

DECAY OF IRON AND STEEL IN ENGINEERING WORKS.*

By W. H. Maxwell, Assoc.M.Inst.C.E.

DURING recent years, the writer has been called upon to give close attention to the question of the relative durability of various metals subjected to corrosive influences, as met with in structural engineering, more particularly in connection with deep-well work for public water supply purposes, in steel bridge work, and in boilers and steam engineering generally.

The remarks which follow are in no sense intended to be a complete survey of the subject of corrosion of iron and steel, but simply to outline a few of the more practical points as met with in practice.

At the outset, it may be observed that, however simple the usual text-book theory may appear in regard to the common phenomenon of the corrosion of metals, such as the rusting of common iron or steel, those who are responsible for the prevention of corrosion in important engineering structures will soon realize that the problem is one of much greater complexity than a case of simple oxidation, as commonly supposed. The underlying causes and remedies for such deterioration are still somewhat imperfectly understood, and, even in the simplest cases, there remains room for fuller investigation.

Complications Affecting Corrosion.—In most cases met with in practice, it is not a question of investigating the action of water and air upon *pure* iron, but the deterioration to be arrested is invariably found to be the product of these substances mixed with numerous impurities, thus giving rise to an almost endless variety of conditions and results. The impurities of water and air vary with the locality, and the precise composition of metal is often a varying and elusive contingency of manufacture, somewhat difficult to trace and control.

Commercial Iron and Steel.—In view of the fact that commercial iron and steel are not uniform in composition, and that water and air are invariably contaminated in numerous ways, it is not surprising that the growth of knowledge on the subject has been slow, and that many of the opinions formed have since proved erroneous.

Want of Uniformity in Composition of Metals.—In the case of ordinary commercial irons and steels, the more soluble constituents dissolve out first, according to the nature of the liquids or other deteriorating influences with which the metals are brought into contact. Different batches of steel cannot be depended upon for uniformity of composition and equal durability under like circumstances.

Great care should be taken to prevent irregularity of composition in iron if corrosion is to be retarded. The greater uniformity of wrought iron, as compared with steel, also renders the former metal more resistant to galvanic activity.

Segregation in Metals.—Steels usually show great tendency to segregate, owing to the different temperatures of solidification of their constituents, and the smaller the proportion of iron present the greater is the want of uniformity due to segregation. Under these conditions, differences of potential exist, galvanic activity is set up, and the steel becomes highly corrodible.

*Extract of paper presented in the Journal of the Institution of Municipal and County Engineers (Great Britain).

Uniformity of Coatings Necessary.—Provided the metal can be completely covered with an efficient protective coating in order to insulate it from other metals or from the electrolyte in which it may be immersed, resistance to corrosion will be increased, but it is essential such coatings should be entirely continuous, otherwise, galvanic currents may be concentrated at points or pinholes, and thus cause greater damage than if uniformly distributed over the entire surface of the metal.

Local Conditions Affect Rate of Corrosion.—The behavior of metal is very largely dependent upon the precise local conditions to which it is subjected; for example, a strong industrial atmosphere may give rise, in the presence of moisture, to a powerful corrosive action. The writer has often experienced the highly damaging effect of fumes from passing locomotives upon mild steel bridge work exposed to such fumes in the presence of moisture.

Practical Observations.—Also, he has found that steam boilers and condenser tubes sometimes become pitted and grooved in a very unaccountable manner. Two or more boilers installed at the same date, made of similar material, fed with the same class of feed water, and worked under like conditions have oftentimes been observed to give widely divergent results—one being in good condition after 15 years' use, whilst another may become seriously pitted within one-fifth of that time. The repair of an old boiler with new boiler plate sometimes hastens the destruction of one or other of the metals, but it is impossible to foretell which metal will be the first to fail. The best classes of iron, such as Low Moor, are invariably more reliable than modern mild steel, which is a composite material involving many uncertain complications.

Metals Immersed in Corrosive Waters.—The writer has closely observed, for many years past, the varying degrees of corrosion occurring in the case of wrought iron, mild steel, and cast iron immersed in corrosive waters in structural works, particularly when these metals are used in juxta-position with gunmetal and other alloys. In the latter case a very marked and rapid deterioration of iron and steel has been observed to take place in certain natural waters, and under conditions such as these, the author has been engaged upon investigations into the question of the most suitable method of lining bore-wells 336 ft. deep by 3 ft. 6 in. diameter, for water supply purposes.

Deep-well Linings.—The usual mild steel linings were found to be inadmissible, owing to their very limited life under the conditions to be dealt with, and cast iron tubes with specially machined points were finally decided upon—a double lining being used through the first 165 feet of impermeable clay with the annular space between the inner and outer tubes grouted up with Portland cement grout. Great care was taken that no machined parts of the metal were exposed to the action of the water—these being protected by bituminous composition, and by closely fitted metal sleeves.

Foundry Skin.—Except where fully protected in this way, the foundry skin of the metal was not allowed to be broken, as this skin was found to have a strongly resistant action to the corrosive tendencies of the water. Should any machined face of the metal be exposed, deterioration will proceed rapidly at that part.

Uniformity and Insulation of Metals.—In all such works where metal must be fixed in contact with corrosive waters, the metals used should be as uniform in composition as possible, and if the employment of different

metals is unavoidable, they should be insulated from each other as perfectly as possible.

Cast Iron More Resistive Than Steel.—Under many circumstances cast iron is much superior to either wrought iron or steel, and the closer the grain of the cast metal the more perfectly will it resist corrosive influences.

Action of Pure Iron, Air and Water.—Absolutely pure iron, if it could be obtained, would be unusually resistant to corrosion, unless placed in metallic contact with dissimilar metals. It is interesting to note that the action of pure water and pure air upon pure iron is but slight, and for all practical purposes negligible, but inasmuch as all these commodities are scientific curiosities of the laboratory rather than matters of ordinary experience, the point is not of direct practical importance, except in so far as it indicates the direction in which causes of corrosion may be expected to lie.

Moisture Hastens Corrosion.—Whilst there are many points still the subject of controversy, investigators appear to be agreed that, unless water is present, iron will not rust in air or oxygen. Natural rain-water and mist show great activity in the oxidation of metals, and water, when saturated with air is strongly corrosive to iron and steel. Corrosion proceeds most rapidly when the metal is alternately subjected to wet and dry conditions, such as at the water-line of iron columns, ships, boilers, water tanks, and the like. Deterioration of the metal at the water-line in boilers is a very generally noticeable condition.

Effect of Deeply Immersing and Burying Metals.—Water surfaces in contact with the atmosphere become more or less saturated with oxygen and the corrosive action of the water is consequently increased. Ironwork is much less corroded when immersed to a considerable depth in water than when placed near the surface, where air gains access.

Acids in Soils.—Deeply burying of metal in the soil has also been observed to have a preservative effect, as free oxygen cannot readily reach it. Should the soil, however, contain acids or acid salts these will soon have a destructive effect on the metal, as also will stray electric currents by the setting up of "electrolysis," resulting in rapid corrosion. It has also been observed that exposure to the action of diffused sunlight stimulates the rate of corrosion of iron.

"Busy" Iron.—Railway metals in active service corrode less rapidly than do similar rails laid in sidings which are little used. It may also be taken generally that "busy" iron, and iron subjected to vibration, has been observed to rust much less rapidly than idle metal subjected to similar corrosive influences. A thick scale of rust on the surface of metal retains moisture and hastens further corrosion.

Painting of Metals to Prevent Corrosion.—In regard to the question of painting or "coating" of metals with a view of preventing corrosion much consideration is needed, or more harm than good may result. A form of specification commonly seen requires "all ironwork to receive one (or two) coats of paint before leaving the manufacturer's works." The wisdom of this is very doubtful, inasmuch as the "mill-scale" on the new ironwork is certain to come away sooner or later as oxidation sets in under the paint, and the latter coating will thus be brought away with the scale. In the use of some proprietary "coatings" it is, in fact, recommended that a first coat be applied and allowed to peel away, should it prove disposed to do so, in order that all scale may be removed therewith, and the subsequent coatings will then permanently adhere and protect the metal.

In the galvanizing and other similar trades the mill-scale is removed by dipping the steel and iron goods in hydrochloric acid solution before coating the metal.

Removal of "Mill-scale."—Before painting iron and steel work, as in bridges, etc., the black oxide scale, or "mill-scale," may advantageously be permitted first to turn to red oxide or rust, and the metal then be thoroughly well cleaned with wire brushes or sand blast. This having been well done, the paint will then find its way direct to the metal and form a much more permanent coating. It is often a difficult matter to remove every trace of mill-scale, but the improved results obtained justify this precaution.

Many engineers now frequently allow iron and steel structures to stand for a while and rust, in order that the mill-scale may be loosened and so come away more freely by scraping and wire-brushing, before any coat of paint is applied.

Rust is capable of setting up galvanic activity, but to a less degree than is the case with magnetic or black oxide.

Necessity of Continuous Coatings.—Numerous "coatings" of varying composition have been largely used on all classes of work in which metals are extensively employed. In the case of steel pipe-line in wet soils or situations, the conditions are severe, and no permanently effective coating is at present available. The application of the coating is also of first importance. It should be absolutely uniform and continuous, otherwise, should there be imperfections, such as small holes, galvanic currents leave the metal plates at these points, and the iron or steel work becomes more quickly corroded than would be the case if the same action took place uniformly over the whole surface.

"Coatings" May Prove Detrimental.—Artificial coatings, intended for protection, may thus not infrequently become sources of danger, and, in the case of some paints, the coarser particles of pigment may induce galvanic activity under the paint. It will be advantageous, therefore, to use a pigment which is a bad conductor of electricity, finely ground, and well incorporated with oil.

R. H. Gaine's General Comment.—The whole subject of the corrosion of iron and steel abounds in curious anomalies, and apparently similar materials do not always behave alike under what may be believed to be identical conditions. The general comment on this subject of Mr. R. H. Gaines, the eminent chemist to the New York Board of Water Supply, is of special interest. In a report on the corrosion of a 38-in. diameter steel conduit at Rochester, New York, it is observed that:—

"The corrosive influences of nature can never be precisely imitated, and, moreover, the time during which laboratory experiments extend is relatively so short that they are of little value compared to actual experience. Besides, practical experience on such subjects is always more reliable than mere laboratory experiments. . . . There is a wide divergence of opinion among metallurgists on the corrodibility of the various forms of iron. Experience at Rochester, Portland, and elsewhere, seems to show that cast iron resists corrosion better than any other form of iron, and wrought iron is less easily corroded than mild steel. As between steel and wrought iron, some metallurgists claim that the difference is slight, but their reported experiments have not been carried far enough to base a final opinion."

Failures of Steel Pipe-lines.—A number of very costly failures, due to corrosion, are on record in regard to mild steel pipe-lines. The use of this material for water conduits was adopted some 25 years ago, and, so far as durability is concerned, may almost be said to be still in the experimental stage. But, apart from the probability of early deterioration, mild steel mains have many advantages from a structural engineering point of view, such as greatly reduced weight, as compared with cast iron, for a given carrying capacity, greater reliability under heavy pressures, and generally increased adaptability to meet the conditions of route of any particular pipe-line.

38-in. Main, Rochester, New York.—The steel pipeline in connection with the Rochester water undertaking, New York, already referred to above, is 38-in. in diameter and 26 miles long, and, within 6 years of being brought into use in the year 1894, rust-hole leakage, due to external corrosion, took place.

Causes of Failure.—The cause of this failure was attributed to "electrolysis," and occurred in parts of the main laid in wet soils. Corrosion is found to be much retarded in dry, sandy or well-drained soils. Subsoil water in contact with steel in such cases is found to produce electromotive force from electro-chemical action, and the electrolytic damage is proportional to the time during which the current acts.

The three leading conditions which brought about serious corrosion in the Rochester main were: The wet soils through which the main was laid, ineffective protective coatings, and want of uniformity in the composition of the steel.

Even in the best and most uniform qualities of steel there exist contiguous areas of different electrical potential, and if the steel tubes lie in contact with an ionized solution, like soil water, corrosion will occur by electrolysis, as in this case.

Failure of 30-in. Main in Australia.—Another case of serious corrosion occurred during recent years in connection with a large and costly steel main 350 miles long by 30 in. diameter, in Australia—the corrosion being first observed about 3 years after completion. The official reports in such cases form an instructive study to those interested in such matters.

Relative Durability of Cast Iron, Wrought Iron, and Mild Steel.—The relative durability of cast iron, wrought iron, and mild steel is a matter of considerable commercial importance. In the case of cast iron, it would appear, in some instances, that no practical limit can be put upon this material when used under suitable conditions. The cast iron flanged pipes supplying water to the great fountains at Versailles were laid in 1685, or 229 years ago, and are stated to be still in use. Evidence is also available of cast iron bridges having been in use over a century and a quarter without visible deterioration from corrosion. Some wrought iron bridges are said to have shown over 60 years' service, but as regards mild steel bridges the life is usually much less, some such structures having become unsafe from corrosion after 25 years' use. In the author's experience, when mild steel bridges arrive at about this age, much annual attention is necessary to cope with deterioration due to corrosion.

Influence of Electrolytic Activity, Strain, etc.—In the decay of metals by corrosion, electrolytic activity is a much more serious factor than was formerly thought, and its action is of a subtle and elusive nature and difficult to stop. Many intricate complications arise, e.g., iron subjected to strain or uneven treatment, generally speaking, corrodes more rapidly than that treated uniformly. A difference of electrical potential exists between strained and unstrained pieces of similar metal, also between tempered and untempered portions. Galvanic activity can therefore be induced by immersing metals under these conditions in electrolytic solutions, and corrosion of the anodic metal results.

In some experiments strained portions of metal were found to be cathodic to the unstrained, and the latter specimen was therefore attacked the more vigorously.

No Rules Generally Applicable.—No general rules appear to be universally applicable, but the important point for engineers to bear in mind is that a difference of electrical potential does exist, and that strain of any kind will induce such change of potential, resulting, when immersed in an electrolytic solution, in corrosion due to galvanic activity. Beforehand, it is difficult to say whether the strained or the unstrained portion will act as the cathode, and so be preserved at the expense of the other, as the difference of potential is small and dependent on the actual local conditions of the case in point.

Differences of Potential.—Differences of potential between two metals placed in the same electrolyte under different conditions do not always remain constant. The potential difference may change in degree, and in some cases even the polarity may undergo reversal. The metal which is at the higher potential corrodes and constitutes the "anode," whilst the cathodic metal will remain unaffected.

Reversals of Polarity.—In cases where reversals of polarity occur, owing to the initial difference in potential being slight, both metals will corrode proportional to the time each has served as the anode.

Potential Difference.—Potential difference depends upon the chemical nature of the electrolyte, on its degree of concentration, temperature, rate of motion and other factors.

Means of Retarding Corrosion.—Corrosion due to galvanic activity can be retarded by securing greater uniformity of composition in the metal, a minimum of segregation as occurring in steel, uniformity of physical condition in the metal, and protection from moisture, which will act as an electrolyte.

Theories of Corrosion.—Although the foregoing observations on the corrosion of metals are intended to bear primarily upon the practical side of the question, a brief reference to the principal theories of corrosion which have been suggested to explain the cause of this great waste and decay which takes place may be of interest in the present connection.

Many theories have been proposed, but two only merit serious consideration, viz.: the acid and the electrolytic theories respectively.

Acid Theory.—According to the acid theory, oxygen, *pure* water and iron may remain in contact indefinitely without producing rust, the presence of a trace, at least, of some acid being essential to the oxidation of the metal. Carbonic acid, being naturally prevalent in air and water, is generally understood to be the primary cause of attack in ordinary cases of rusting.

Electrolytic Theory.—The electrolytic theory, on the contrary, depends upon the solubility of iron in pure water, and maintains that the presence of even traces of an acid is not necessary to its oxidation, but that water

and oxygen alone are essential. This theory depends upon the presence of free hydrogen ions in the purest water, and the experimental work done shows rusting to be principally due to attack from this source.

Differences of Opinion.—As indicating the unsettled state of scientific opinion on the theoretical side of this question, it may be observed that one authority, whose views on the subject command the greatest respect, considers the balance of evidence decidedly in favor of the acid theory, whilst another, of equal eminence, strongly urges the electrolytic doctrine.

Use of Theories.—Whilst the ordinary user of metals may look upon these different theories as of little moment, and regard the fundamental distinctions between them as theoretical rather than practical, it should not be overlooked that a reasonable tentative conjecture respecting the cause of any phenomenon may have its uses as a working hypothesis.

Commercial Importance of Inhibition of Corrosion.—The present may be looked upon as the age of iron and steel, and the commercial importance of the subject of the corrosion of metals can scarcely be over-estimated, inasmuch as in almost every department of constructive work these materials are increasingly used, and, in view of the universally heavy costs of maintenance and renewals due to corrosive deterioration, no problem, perhaps, holds out greater prospects of reward, both to the scientific investigator and to the manufacturer alike, who shall commercially produce more resistant metals than those now available for the general structural requirements of the engineer.

A Swedish engineer has patented a process for the manufacture of cement in electric furnaces, which has been found practicable. Hitherto, the manufacture has been made difficult by the formation of calcium carbide that ruins the cement. The method of overcoming the difficulty consists in adding a metallic oxide to reduce the carbide. Iron oxide has proved a suitable material, and, instead of including this in the charge of the furnace, it has been found sufficient to add the powdered oxide to the cement product taken from the furnace.

In a report by United States Deputy Consul-General Loop of London, to the Treasury Department, it is said that pneumatic grain elevators are used in England by practically all of the large grain handling and milling concerns located at the various ports, and are regarded as being very successful. The average quantity of grain dealt with in an hour by such elevators, may be taken as 100 tons, (ton equals 2,240 lbs.), though the largest plants are capable of dealing with 150 to 200 tons of grain per hour, while smaller ones are in use dealing with as little as 5 tons per hour.

It has been announced in London, England, that work on the tunnelling for the underground railway to be constructed to facilitate the handling of mail matter in England, is to be commenced immediately. Comprehensive plans have been prepared for the project, which show an underground narrow-gauge automatic railway which will link up all the principal railway terminals with the district post offices. Interesting tests were shown recently at Chelmsford with automatic electrical trains working on an experimental railway. The track has an 18-inch gauge, and is half a mile long. It contains curves of very sharp radius, and runs part of the way through a tunnel, such as the Government has decided to construct. The tunnel is just high enough to enable a mechanic to walk upright through it, with a track on each side for trains. Pneumatic tubes are suspended from the roof, and there is provision for telegraph and telephone wires, to the right and left underneath. The cars, which are 2 feet wide, 2 feet high, and 6 feet long, are constructed to permit the carrying of large parcels and mail bags. They carry no operators, but are controlled automatically until they arrive at a station, travelling at an average speed of 30 miles an hour and being despatched at one minute intervals.

REINFORCED-CONCRETE HIGHWAY BRIDGES AND CULVERTS.

AT the annual convention of the American Concrete Institute, held in Chicago February 16-20, 1914, the Committee on Reinforced Concrete Highway Bridges submitted the following tentative recommendations and suggestions. The report was intended to be a preliminary one, to deduce discussion from the members of the Institute. Mr. Willis Whited is chairman of the committee. The other members are Messrs. A. N. Johnson, H. H. Quimby, A. M. Loves and Lemuel Holmes.

Dead Loads.—The following are given as average weights per cubic foot of the materials mentioned, but if the weights of the materials to be actually used are definitely known to be different from those given, the correct weights should be used.

Materials.	Lb. per cu. ft.
Earth filling	110
Plain concrete	150
Reinforced concrete	155
Steel	490
Cast iron	450
Vitrified brick	140
Common brick	125
Granite and limestone masonry.	165
Sandstone	160
Macadam-Telford	150
Pine, fir, etc.	42
Oak and yellow pine	48
Creosoted timber	60

The weight imposed by earth filling should, in ordinary cases, be considered as including all filling included between vertical planes passing through the faces of the abutments.

If, however, the height of the fill exceeds about two-thirds the distance face to face of the abutments, the live load may be neglected and a very considerable proportion of the weight of the filling considered will be supported by friction between it and the approach filling. The amount of load thus transmitted is greatly affected by the cohesion of the soil, of which there is nearly always more or less.

This whole subject requires further investigation.

Live Loads.—Class "A" Bridges—Main thoroughfares leading from large towns.

In view of the extensive introduction of the heavy motor trucks and traction engines, and the probable general use of such vehicles in the future, it is recommended that bridges on main thoroughfares and other roads which are likely to be used for heavy hauling, be designed to carry 20-ton trucks, with axles about 10 ft. c. to c., 14 tons on rear axle and 6 tons on fore axle; wheels about 5 ft. c. to c. Outside of the large cities it is recommended that only one such vehicle be assumed to be on the bridge at any one time, the likelihood of more than one being on the bridge, in a position to produce maximum stresses at the same time, is so remote that this assumption is considered safe. It is advised that such very heavy loads be considered as occupying only the ordinary width of the road, about 8 ft. in width, and about 35 ft. in length. Congested traffic of heavily loaded wagons or motor trucks will rarely impose a load of more than 100 lb. per sq. ft., over a considerable area. The above-mentioned 20-ton truck gives a load of about 140 lb. per sq. ft., on the area actually occupied, but it is considered

extravagant to assume that a large bridge is covered with such heavy loads. One hundred pounds per square foot is thought ample to assume for the loading of spans more than 60 ft. long, in designing the trusses or main girders. It is thought to be safe to reduce this assumed load in the case of longer spans, to the following amounts:

Length of span, ft.	Assumed load, lb. per sq. ft.
80	90
100	80
125	75
200 and over	70

With all intermediate spans in proportion.

The greatest load that is liable to be imposed on a bridge sidewalk, occurs when there is some excitement in the neighborhood, which attracts a large crowd, and for which the bridge affords an especially good point of view. In that case the crowd forms a compact mass, against the railing, not more than 4 ft. deep, making a load seldom exceeding 100 lb. per sq. ft., over a very considerable space. The remaining portion of the sidewalk may be covered by a moving crowd which can scarcely weigh more than 40 lb. per sq. ft. It may be advisable, sometimes, to so design sidewalk slabs, that if a street car or motor truck accidentally gets upon the sidewalk, it will not go through. Such accidents are so rare, that it is thought safe to allow materials to be stressed somewhat beyond the elastic limit in such cases.

Class "B" Bridges—Although it is impossible to determine beforehand, especially in the newer parts of the country, whether any given road is to be used for heavy traffic, it seems extravagant, at least in the cases of larger spans, to design bridges to carry much heavier loads than can be expected to come upon them. It is recommended that bridges of this class be designed to carry 15-ton trucks, with axles 10 ft. apart, 5 tons on the front and 10 tons on the rear axle. This will allow for a considerable overloading of existing motor trucks. It is further recommended, that only one truck be assumed to be on the bridge at one time, in designing the floor system, that it be assumed to cover a width of 8 ft. and a length of 35 ft. and that the remainder of the bridge is covered with a load of about 90 lb. per sq. ft., for spans up to 60 ft.

The longer spans, the trusses and main girders should be designed for the following loads:

Length of span, ft.	Assumed load, lb. per sq. ft.
80	80
100	70
125	65
150	60
200 and over	55

With intermediate spans in proportion.

Sidewalks should be designed to carry the same loads as in the case of Class "A" Bridges.

Special Bridges—City bridges and bridges carrying traffic connected with mines, quarries, lumber regions, mills, manufactories, etc., require special consideration and should, of course, be designed to carry any load which can reasonably be expected to pass over them, bearing in mind the likelihood of heavy traction engines and motor trucks coming into extensive use in the not distant future.

Stringer Loading.—The maximum stress in a stringer, due to a wheel load, occurs evidently when the wheel is directly over it. It is not thought proper to assume any distribution of the load to adjacent stringers, unless the bottom reinforcement in the slab is made continuous. In that case the distribution is proportional to the relative stiffness of the slab and the stringers, said stiffnesses being proportional to the moments of inertia, multiplied by the modulus of elasticity of materials and inversely proportional to the cube of the span. In determining this distribution, due account must be taken of the fact that deflection of the slab decreases toward the end of the stringers, and also of the fact, that whatever load is carried to the adjacent stringers, deflects them also. It is therefore recommended that wherever practicable the bottom reinforcement of slabs be made continuous over the stringers.

Slab Loading.—The distribution in a direction parallel to the supports of a concentrated load resting on a slab, supported at two opposite edges only, evidently depends upon the same principles as those mentioned under "Stringer Loading." The main difference being that what corresponds to the stringer in the former case is of indefinite width in the present case. Adequate theoretical investigations of this question appear to be lacking. For the present it seems fair to assume that the distribution each side of a concentrated load is equal to about one-third the length of the span, and that the cross reinforcement should be designed accordingly, which would require it to have an area of at least one-half of the principal reinforcement. The distribution of a concentrated load through earth filling on the top of a slab does not appear to be very well understood.

Bridges Carrying Electric Cars.—Electric traction is still in its infancy and nobody is able to forecast its future development. It seems probable, however, that it will not be profitable to run cars weighing more than 50 tons each, at a speed that would be permitted on any public road. If very high speeds are desired, the traction company will doubtless be required to operate over its own right-of-way. It is recommended that bridges carrying either urban or interurban electric cars be designed to carry 50-ton cars on two trucks, spaced 30 ft. c. to c., each truck having two axles spaced 7 ft. c. to c. The committee sees no reason for changing the customary practice of assuming that an axle load is distributed over 3 ties.

Loading on Arches.—The deflection of an arch being much less than that of a beam of the same length, the method recommended for determining the lateral distribution of a concentrated load over arch sheeting appears to be different from the distribution over flat slabs. It seems doubtful if the distribution in each direction can be greater than twice the thickness of the arch sheeting. This question should be investigated.

Stresses in Arches.—As all arches that are not provided with hinges act as elastic arches until cracks are formed, due to excessive tension at some point or points in the concrete, it is manifestly proper to calculate the stresses in them according to the elastic theory.

As concrete is a very poor conductor of heat, it is not thought necessary in calculating reinforced-concrete arches, to assume so much variation in temperature as is usual in designing steel structures, although the outside layers of concrete are of nearly the same temperature as the surrounding air, and those layers are stressed more heavily than any of the others, it is thought that an extreme variation of about 80° F. in the Northern States is sufficient to allow for, in any case, and that can be reduced if the arch ring is thicker or if there is much earth filling in the spandrels.

Bearing Power of Piles.—The usual formula for the safe bearing power of wooden piles is:

$$B = \frac{2\,W\,H}{S + 1}$$

in which,

W = Weight of hammer in pounds,
H = Height of fall of hammer in feet,
S = Penetration in inches per blow, average of last few blows.

If reinforced-concrete piles are molded before being driven, the head of the pile is usually cushioned more or less, and the pile is generally much heavier in proportion to the weight of the hammer than is the case with wooden piles. It is recommended that the hammer should be at least as heavy as the pile.

If concrete piles are molded in place, measures should be taken to prevent damage to them by the driving of neighboring piles or otherwise.

Bearing Power of Soils.—This subject is under an investigation by a committee from the American Society of Civil Engineers. It may be some years before their final report is submitted and even that will be subject to revision from time to time, as human knowledge is extended. In the meantime the committee would submit the following preliminary table:

Material.	Safe bearing power, tons per sq. ft.		
Quicksands and wet soils	0.1	to	1.0
Dry earth, according to depth below surface	1	to	3
Moderately dry clay confined	2	to	4
Dry stiff clay	4	to	6
Sand confined	2	to	6
Sand compact and cemented	4	to	8
Gravel cemented	8	to	12
Rock	25	to	200

Foundations should be carried down below frost unless they are on rock and thoroughly drained. Soil that contains the roots of plants is generally compressible. Undisturbed soil is much less compressible than filling or similar soil, even though it has been in place many years. The bearing power of sand, gravel and dry clay increases rapidly with the depth below the surface of the ground. None but the smallest structures should be founded on earth filling.

The pressure of earth against abutments, wingwalls and retaining walls varies so widely with the character and condition of the earth in question, that nothing more than a few general suggestions can be given. It is hoped that the committee from the Society of Civil Engineers, which is studying the bearing power of soils, will take up this subject also. In ordinary cases where the filling is well drained its pressure will seldom be more than that of a liquid weighing 25 lb. per cu. ft., and is frequently much less. The pressure due to land slides is often several times this amount. If the filling is clayey and is allowed to become waterlogged, its lateral pressure is greatly increased. The effect of the freezing of the filling must also be considered.

Required Waterway.—The usual formula for waterway for culverts is:

$$a = C A^{\frac{3}{4}}$$

in which,

a = Required area of culvert in sq. ft.
A = Drainage area in acres.
C = A constant, depending on the length and character of the drainage area and may vary from about 0.3 to 2.0 in regions where the mean annual rainfall is about 50 in.

The capacity of the culvert will be much greater if the wingwalls are flush with the abutments and flare about 30°, the sides and bottom of the culvert are smooth and straight, and the bottom has a good slope.

If reliable information covering a number of years can be obtained regarding the adequacy of the old bridge crossing the same stream, it is much more useful in determining the size of a culvert or bridge than any formula.

PANAMA CANAL EXCAVATION.

The grand total of Panama Canal excavation to February 1, 1914, was 216,966,610 cu. yd., leaving 15,386,390 cu. yd. remaining to be excavated under the revised estimate of July 1, 1913. The total excavation for the month of January was 1,514,972 cu. yd., as compared with 1,581,726 cu. yd. for December. The wet excavation amounted to 1,118,464 cu. yd., and the dry excavation to 396,508 cu. yd.

ALASKA TIMBER CONTRACTS.

Arrangements have been made by the United States Forest Service to advertise for bids for 40,000,000 feet of Sitka spruce and hemlock timber in the Tongas National Forest, Alaska. The timber is in two bodies, the larger consisting of 38,000,000 feet on the Fish creek watershed, Baranoff Island, 30 miles north-east of Sitka, and the other 2,000,000 on Thorne River, Prince of Wales Island. Six years will be allowed for the removal of the larger tract and two for the smaller. The initial rate of $1 per M. for the spruce and 50 cents per M. for the hemlock, with two optional increases in the stumpage rates not to exceed 50 cents per M. in the Baranoff tract and one such increase in the Prince of Wales tract, is provided for.

RIVER IMPROVEMENT IN RUSSIA.

It is reported from St. Petersburg that the Russian Government has given to an American syndicate of capitalists the contract for the contemplated improvements on the Volga River and its tributaries. The work includes extensive dredging, is to be supervised by an American staff of engineers, will be finished within 5 years, and is estimated to cost 500,000,000 roubles.

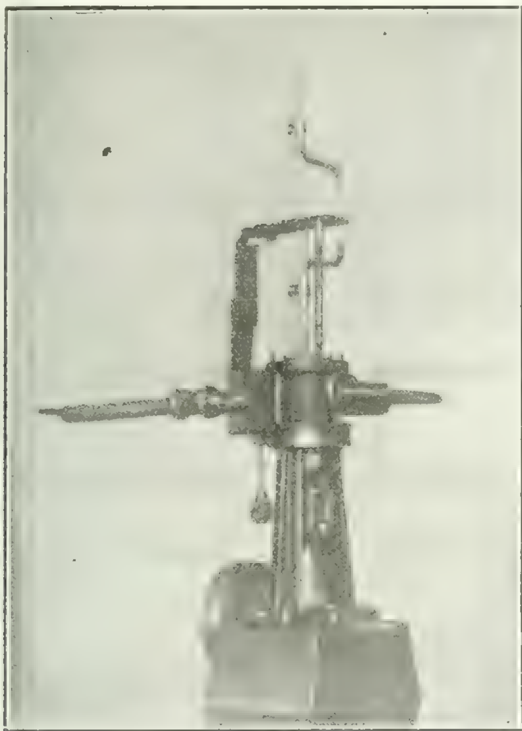
Fraser and Chalmers of Canada, Limited, 4 Phillips Place, Montreal, have been appointed Canadian agents for W. H. Allen, Son and Co. Limited, of Bedford, England, engineers and builders of steam, hydraulic and d.c. electric machinery.

Canadian Allis-Chalmers, Limited, Toronto, have been appointed exclusive agents for Canada and Newfoundland, of the Avery automatic scales. The parent factory, at Birmingham, Eng., was established almost 200 years ago. The scales are of value in power plant installations for checking the amount of coal and water feed to boilers, in weighing liquids for sugar and oil and other industries, and in cement plants to determine automatically the proper proportions of the various ingredients. The Avery scale in the Canadian Government elevator at Port Colborne is said to be the largest automatic grain scale in the world.

A NOVEL USE FOR A STEAM ENGINE.

Mr. W. L. McLaren of Ottawa sends in the following interesting description of an impromptu method which he applied to cutting irregular holes and spaces in some thin pieces of metal. Finding that drilling and filing these holes by hand promised to occupy a considerable time he devised a method of using a small upright steam engine which he had made several years ago for experimental purposes. The stroke and bore of the engine were each about 1 inch in dimension.

After removing the piston rod and head, a hole was drilled the size of the former in the centre of the cylinder head, and the shank of the saw, being of the same cross-sec-



tional area as the piston, was run entirely through and connected with the cross head in the same position is the piston.

To reduce the number of moving parts, the eccentric and eccentric strap were removed, and the fly wheel of the engine was then belted to the countershaft on his bench lathe.

A table was improvised, using an ordinary clamp and a couple of pieces of flat iron as shown in the accompanying photograph, the pieces being bolted so as to allow of small adjustments. The outfit could be readily taken down or set up in a few minutes' time.

The question arises why the shank of the saw was not merely connected directly to the piston and the apparatus run by steam. This was not feasible as steam was not available, and because the engine was of such a small size that it would hardly generate sufficient power to do the work; whereas, when the outfit is operated by belt it transmits sufficient power and allows a variation of speed by the changing of the speed of the countershaft.

By plugging the hole in the centre of the cylinder head the steam engine may again be used for its original purposes.

The Dominion Engineering and Inspection Company, of Montreal and Toronto, have been appointed to inspect the fabrication of the travelers to be used for placing the centre span of the Quebec bridge. These travelers will be manufactured by the Structural Steel Co., Limited, for the St. Lawrence Bridge Company.

SOME FEATURES OF THE MACHINERY EXHIBIT AT THE PANAMA PACIFIC-INTERNATIONAL EXPOSITION.

Such great advances have been made during the last decade in the perfecting of methods of shaping metals, that many of the machines for this work are of extreme interest. Also, the improvement in the processes of producing purer metals has contributed its part toward making many of these methods possible and practicable. Every visitor to an old-time machine shop, and such a shop existed up to a very few years ago, recalls the long lines of shafting, pulleys and belts overhead for transmitting power from the engine that drove the shop to the machine that did the work. All, or nearly all, of this arrangement has now given way to the system of driving each machine by electric motor. The steam engine in the shop no longer drives a long line of shafting, pulleys and belts, but drives, instead, a generator, supplying power to the motor mounted on each machine, and, in this way, any one machine may be operated while the remainder of the shop is silent.

The rapidity of work always counts if quality is not sacrificed, and the use to-day of special steel alloys for making cutting tools has rendered possible high speeds of cutting thought impossible a decade ago. Some of these high speed steels are so hard and tough that they can cut an enormous chip from a piece of metal, making both chip and tool point red hot, yet not wearing away unduly the point of the tool.

These machine tools include lathes, planers, shapers, drills; boring, milling and slotting machines, besides tools for special kinds of work. In fact, a milling machine might be called a special tool, as it can do a remarkable variety of intricate work in shaping metal, and its precision is far greater than can be obtained by hand work.

Among the most interesting of the special machines that will be shown at the Panama-Pacific-International Exposition in celebration of the completion of the Panama Canal is the screw-cutting machine, which makes not only wood screws and bolts, but a great variety of articles that are cut from a revolving piece of metal, such as lock tumblers, sewing machine shuttles, hollow nipples for gas fixtures, and the like. These machines are almost human, and an intelligent boy in a shop can look after the operation of a dozen of them. After the machinist sets one of these machines with the proper tools for cutting any of the shapes required, all that need be done further is to feed a 16 ft. rod of metal into the machine and set it going. The machine automatically cuts from the end of this metal the screw or bolt or other article, moving about as if human hands were handling the piece and finally finishing it and dropping it into a box. The machine of its own accord feeds the rod further in, so that another article may be made and so on until the rod is entirely used up, and if another rod is not put in immediately the machine stops of its own accord.

Another extremely interesting and recently developed class of machines is composed of those for grinding curved or flat surfaces. These do not use steel tools, but use various wheels made up of emery or other hard grinding material, which revolve very rapidly and perform the required work. In this way, surfaces may be ground to far truer shape than by any other process yet known: for example, the smooth parts of an automobile engine crank can be cut from the rough forging in a remarkably short time.

The metal presses form still another class of special interest. There are many varieties of these for pressing such things as rifle cartridge cases, lead pencil ferrules, collar buttons, small tin boxes and many other articles. These are made from flat discs of metal, and many of them are shaped

completely in one motion of the machine. An interesting process accomplished by one of these machines of the heavy type is that of pressing hubs for automobiles or other vehicles. A hub is pressed, in about 20 different motions of the machine, from a steel disc 15 inches in diameter, and 3/8 of an inch thick. This pressing is done with cold metal, only occasionally is the steel heated to redness to anneal it and keep it from cracking, but it is cooled again before further pressing.

The cutting and shaping of metals is so remarkable that such machines as these, that will be exhibited at the Exposition, will be highly instructive.

NOVA SCOTIA STEEL AND COAL, ANNUAL REPORT.

The annual report for 1913 of the Nova Scotia Steel and Coal Company, recently published at Montreal, stated that the demand for the company's products during the early months of the year had been good. During this period a large tonnage was booked at fair prices sufficient to keep the mills fully employed until the closing weeks of the year, the result being that the outputs of iron ore, pig iron, steel ingots, billets, bars and forgings all showed substantial increases over previous years. Referring to the Wabana iron ore property, the report stated that the company's holdings under title from the Crown now covered 91 square miles; that the submarine development had been further extended by the opening up of levels, cross-cuts, headways and rooms; and that the ore won from this section of the property was over 40 per cent. greater than that of the previous year. It was also reported that good progress had been made in the sinking of the new Jubilee shaft, which would be equipped by 1915 for an output of 1,500 tons per day. A new open-hearth steel furnace was completed during the summer, and a number of improvements to plant and equipment had been carried out.

Investigation of water power development facilities in Nova Scotia has shown that that province has many rivers with capacious lakes for storing purposes, and with a fall from 15 to 100 feet, where from 100 to 30,000-h.p. could be developed at a very reasonable cost. The River Mersey is one of the largest rivers in Nova Scotia. It has a fall of 248 feet from First Lake to tide water, a distance of 17 miles. For power developments already exist on the river, occupying nearly 6 miles of its lower reaches. The whole river has lately been surveyed. It is proposed to raise the level by 20 feet to provide for storage for future developments. Three additional dams are to be built. These dams will transform the river into a series of mill ponds. The total amount of continuous 24-hour shaft horsepower available on the Mersey is estimated at 29,830. The development of this river means the establishment of various new industries in Queen's County.

BACK COPIES WANTED.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, lacks the following issues: Aug. 13th, 1909; Sept. 17th, 1909; Dec. 10th, 1909; Jan. 25th, 1912, and would be glad to pay 25 cents per copy for any of them. Will subscribers who happen to have these numbers, and who do not care to keep them, kindly send them in to this office in order that they are put into the hands of the party interested?

Coast to Coast

Winnipeg, Man.—Before proroguing, the Manitoba Legislature passed a bill to grant $2,500,000 for good roads in Manitoba.

Port Arthur, Ont.—The annual report of the city engineer of Port Arthur for 1913 shows a total expenditure on civic works of $889,749.70.

Brantford, Ont.—At the inaugural meeting of the Brantford Board of Trade for 1914, the purchase of the street railway was strongly recommended.

Saskatoon, Sask.—1913 commenced with a civic deficit of $36,280, and finished with a surplus of $15,130. This is shown by the city auditor's final figures recently presented to the city council.

Toronto, Ont.—Toronto received from this February's street railway earnings $72,057.90, compared with $65,156.95 for February, 1913. The total receipts were $461,274.45; and in 1913, $434,380.17.

Sydney, N.S.—It is reported from Pittsburg, Pa., that within the past several weeks, the Dominion Iron and Steel Corporation of Sydney, N.S., has made sales aggregating nearly 20,000 tons to Philadelphia and New England buyers.

Ottawa, Ont.—The report of the eighth year of operation of the Ottawa Light, Heat and Power Company showed a total net revenue for 1913 as $297,766; while the gross revenue was $834,662, an increase of $54,688 over 1912. During the year $808,331 was expended on new equipment.

Edmonton, Alta.—As soon as the Edmonton city council passes the estimates for the civic works proposed for 1914, it is planned to commence immediately the new system of scavenging. It is believed that greater efficiency will be gained and that also a saving of about $25,000 per year will be effected.

Edmonton, Alta.—The monthly report of the Edmonton power house for December, 1913, which was recently received by the city commissioners, shows a surplus of $9,404; also that the revenue derived from the electric light department was $48,872; street railway, $15,124; and from the waterworks department, $10,480.

Ottawa, Ont.—That portion of the main line from Ottawa to the West on the C.N.R., joining with the Toronto-Winnipeg line at Capreol, is expected to be completed before the end of 1914. Some 150 miles of steel have now been laid; and it is expected that within four months the grading of the line will be entirely completed.

Brandon, Man.—The estimates of the city of Brandon for 1914 allow to the finance committee $52,000 in contrast to $81,000 granted in 1913; to the health department $21,297, as against $22,600; to the board of works department, about $36,000, an increase of about $5,000 over last year; and to the fire and light departments, $65,000, whereas in 1913 an expenditure of $61,500 was allowed.

Moncton, N.B.—The report of the Minister of Public Works for New Brunswick shows an expenditure on ordinary bridges of $173,910.36 out of an appropriation of $272,500; on permanent bridges, $525,123.20; on roads, $138,236.12 out of an appropriation of $272,500; on buildings, $27,101.58 out of an appropriation of $30,500; and on wharves, $16,985.91, out of an appropriation of $17,000.

Saskatoon, Sask.—The city council will make formal application to the local government in the very near future to pass upon new by-laws to the extent of $553,586.05, made up

as follows:—various civic public works contemplated, totalling $293,755; excess expenditure on by-laws already passed, $167,500; and expenditure on works completed or intended to be completed, for which by-laws have not been passed, $92,331.95.

Hamilton, Ont.—The financial statement of the Hamilton hydro-electric department shows a total expenditure on plant up to the end of February of $541,552; and for the year ending December, 1913, a surplus of $5,494 is reported. The principal items of revenue for the year were:—commercial lighting, $22,203; house lighting, $34,451; power, $28,968; and waterworks, $15,542; and the payment of the city to the Provincial Hydro-Electric Commission for power was $47,307.

Port Mann, B.C.—One of the projects which the C.N.R. has under way in British Columbia is the laying out at Port Mann of an immense series of shops and yards which will cost when completed, millions of dollars. The yard accommodation will find room for over 10,000 cars, while an elaborate scheme of trackage, round houses, shops, wood turning mills, and all the adjuncts of a great modern railroad yard and shops will be featured in the most modern and efficient way.

Moose Jaw, Sask.—The report of Moose Jaw's electrical plant shows a tentative financial statement which estimates that the surplus of receipts over expenditures in 1913 will be around $17,000. The total output at the switchboard for the year was 3,762,470 k.w. hours, which is the largest yearly output in the history of the plant. The total amount sold was 2,725,916 k.w. hours. Also the report states that in 1908 the peak load attained was 209 k.w., while in 1913 the highest point reached was 1,475 k.w.

Hamilton, Ont.—The McKittrick bridge to be constructed on King Street West, Hamilton, and the approaches to the bridge, are estimated to cost $110,419, exclusive of the cost of piling. The total cost of the bridge was placed by City Engineer Macallum, including a 120-foot addition to the structure, at $135,000; but so far the cost compiled from tenders submitted and recommended is under this estimate. The Hamilton Bridge Works purpose commencing at once work upon their contract for the superstructure.

St. John, N.B.—The St. John Railway Company reports a successful year's operations, showing a net profit of $66,328.85. A loop extension 1½ miles long has been added to the trackage; new car barns and repair shops, completed; new boiler house and stack in connection with the power plant, erected; considerable new equipment in the power house, installed; and new street cars, purchased. The gas and electric services have been extended and extensive improvements have been made to the company's Seaside Park.

Toronto, Ont.—The public accounts submitted on March 3 in the Ontario Legislature, which show total receipts from all sources for 1913 of $18,472,638, and a total expenditure of $16,091,672, include among the heaviest items of expenditure:—colonization roads, $406,034; Hydro-Electric Commission, $139,592; public buildings, $2,778,689; roads in New Ontario, $1,063,655; advances to the Toronto and Northern Ontario Railway, $950,000; and good roads statutory fund, $288,367. The accounts as presented show a surplus of over two million dollars, but the Government figures a net surplus of $320,000.

Edmonton, Alta.—$41,000 has been subscribed by Edmonton people toward the $50,000 fund to be raised by the Edmonton Industrial Association to explore the natural gas fields at Vegreville. Contracts for boring will be awarded within 10 days. Experts, formerly in the employ of the Governments of Mexico and China, report that commercial gas should be reached in the first well at less than [illegible] feet, in the event of which it will not be necessary to sink more than 1,300 feet on the other two. If the exploration work is successful the industrial association will turn the fields over to the municipality at actual cost.

Newcastle, N.B.—The wireless station at Newcastle is fast nearing completion. One of the two powerful engines, each of 200 h.p., has been erected and tested satisfactorily. The engines are of the Diesel type, burning crude oil, and were manufactured in Legano, Italy, by the Franco Tosi Co., and erected under the personal supervision of Mr. Oslander, of that firm. The work of installing the dynamos and electrical apparatus has been done by Mr. Phael, of Berlin, Germany. Although no messages have been sent from Newcastle, several have been heard in passage from one station to another, mostly from the Glace Bay station.

Prince Albert, Sask.—The Provincial Government is being urged to put in operation the act passed at its last session to provide for the raising of further funds to finance the Prince Albert hydro-electric undertaking. The plant is located at La Colle Falls, and already $840,000 has been spent by the municipality in its construction; but the difficulty confronting the city and hindering progress on the scheme is that no provision has been made for disposing of the power when it has been developed. The original estimate of the cost of the work was placed at $800,000. It is stated, however, that to complete the project satisfactorily, an additional $1,000,000 will be required.

Swift Current, Sask.—The water has been turned on in the new water supply at Swift Current. A dam of 100,000,000-gallon storage capacity has been constructed by the Ambursen Hydraulic Construction Company, and this will provide for a population of 30,000 with a daily consumption of 50 gallons per head. The dam was commenced in August and finished on December 24 at a cost of $100,000. But the pipe line from the dam to the sedementation basement, which was laid by the McManus Construction Company, was completed only within the past two weeks. This main consists of an 18-inch and a 12-inch cast-iron pipe, and exclusive of the land value, has brought the total cost of the new water supply project up to $150,000.

Vancouver, B.C.—With the exception of a 56-mile section south of Albreda Summit, grading has been finished on the Yellowhead Pass-Kamloops portion of the C.N.R. Grading operations from the eastern end of construction have been completed from railhead near Yellowhead to Albreda, a distance of 75 miles; and track laying will be started early in the spring from both ends. Steel has been installed to mile 121 from Kamloops and five miles south from Yellowhead Pass. Several bridges have to be built south of Albreda Summit over the upper reaches of the Fraser River, and a viaduct is now in course of erection over Lyon Creek, a big gully 122 miles north of Kamloops. The latter will be 1,450 feet in length and will be one of the largest bridges on the section.

Victoria, B.C.—The Provincial Government has cut its estimates of expenditure for the year beginning on April 1 by over $4,000,000 less than the estimates furnished for 1913. The estimates call for an outlay for all services of $13,742,000.40, the supplementaries for the year 1913-14 come to $1,298,179.07, and those for the year 1912-13 to $210,438.91 more, or a total to be voted this session of $15,250,627.58. Last year there was voted a total of $19,003,316.50. The revenue estimated for the coming year is $10,048,915.13, which is $277,170 less than was estimated last year. Among the itemized estimates, there is included an expenditure for public works and buildings of $2,319,500; roads, streets, bridges and wharves, $2,861,000; subsidies, steamers, ferries, and bridges, $96,075.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

TORONTO BRANCH, CAN. SOC. C.E.

On the evening of March 5th, the members of the Toronto branch of the Canadian Society of Civil Engineers met to discuss the draft of standard specifications for concrete and reinforced concrete as presented at the last annual meeting of the society. (See *The Canadian Engineer*, January 22nd, 1914, page 198-203.) About 50 members of the branch were in attendance. Mr. A. F. Stewart presided.

Several hours were spent in an interesting discussion of the specifications. Among those who took part were Prof. P. Gillespie, Prof. C. R. Young, Messrs. C. W. Noble, A. W. Connor, D. A. Molitor, H. F. H. Hertzberg, Frank Barber, W. Monds, E. R. Clarke, C. S. L. Hertzberg, E. P. Muntz, T. R. Loudon and A. H. Harkness.

The discussion involved quite a number of clauses in the proposed specifications, relative to both design and workmanship. Among them might be mentioned proportioning of Tee-beams; vertically reinforced columns; use of re-rolled reinforcing bars, spacing of rods; requirements as to sizes of gravel and sand; percentage of compressive stress to ultimate compressive strength; reinforced cinder concrete; proportioning of columns; the use of stirrups; the weight of 1 cu. ft. of cement as 87½ lbs.; modular ratio; bending moments of beams and slabs; form work; measurement of materials; machine mixing; temperatures of placing concrete, etc.

The scope which the specification should have was likewise thoroughly discussed, it being felt by some that the specifications of the Canadian Society of Civil Engineers should be drawn up as a guide to establishing uniformity in design among its members. Others felt that the specification might be complete in itself so that it could be referred to as occasion required by the engineer in his own specifications, in such a way that points not covered in his specifications, might be dispensed with by a clause requiring compliance with the standard specifications on concrete and reinforced concrete of the Canadian Society of Civil Engineers.

Another point that received a small amount of consideration was one in connection with the advisability of embodying in the specifications clauses covering flat slab design.

It was decided by motion to furnish each member with a copy of his discussion in order that he might prepare it for submission to the committee on reinforced concrete.

The meeting was in accordance with the resolution adopted at the annual meeting in Montreal, whereby the draft was to be subjected to a discussion by the branches, the discussion to be submitted to the committee with instructions to report to the Council of the Society.

The Toronto branch held a midday luncheon at the Woodbine Hotel on Thursday, March 12th. Mr. Geo. G. Powell, Deputy City Engineer, Toronto, was the speaker. A good representation of the members of the branch was present.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

On Thursday, March 5th, Mr. J. Stadler addressed a monthly meeting of the Society in Montreal on the subject of "Pulp and Newspaper Manufacture."

NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.

The first National Conference on Concrete Road Building was held in Chicago, February 12th, 13th and 14th. The attendance was between 300 and 400, comprising engineers, contractors, laboratory experts, highway officials and cement representatives. During the sessions 14 reports and six addresses were presented, a notable feature of them all was the earnest endeavour on the part of the speakers to supply the demand for accurate data and scientific knowledge concerning road construction, serviceability and permanence. Although the proceedings of the Convention was restricted to concrete roads alone, with little or no reference to any other type, the subject in itself was found by no means narrow and the sessions produced some valuable information and animated discussion. The conference will undoubtedly result in a greater interest in the general subject of road building, and the educative work associated with the meeting will make itself felt throughout the country.

The results of the Conference were summarized in the recommendations of the Committee on Resolutions, the important points of which are briefly abstracted as follows:—

1. The aggregates should be clean and hard.
2. The sand should be coarse and well graded.
3. A rich mixture should be used.
4. The materials should be correctly proportioned.
5. The materials should be thoroughly mixed.
6. The inspection should be intelligent and thorough.
7. When in doubt, reinforce the pavement.
8. The sub-grade should be of uniform density, thoroughly compacted and drenched with water immediately before placing concrete.
9. The concrete should be of a viscous, plastic consistency.
10. After placing, the concrete should be immediately covered and kept moist and not opened for traffic for four weeks.

Besides the addresses, the principal reports received and discussed dealt with the following topics:—Contraction and Expansion of Concrete Roads; Aggregates for Roads; Preparation and Treatment of Subgrade Reinforcement.

Summaries of reports and addresses will shortly appear in *The Canadian Engineer*.

AMERICAN ROAD BUILDERS' ASSOCIATION.

The 11th annual convention of the American Road Builders' Association will be held early in December next in Chicago.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The Toronto section of the A.I.E.E. held its third regular meeting for the year on the evening of March 6th. Mr. Geo. H. Hill of the General Electric Company, Schenectady, N.Y., presented a paper entitled "High Tension Direct Current Railways." The address was illustrated by motion picture and lantern views.

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.

At its meeting on February 27th, the members of the Engineering Society of Queen's University were addressed by E. L. Cousins, B.A.Sc., Chief Engineer, Toronto Harbor Commission, who spoke upon the proposed improvements to the Toronto water front. In the course of the description of the supposed development of the Toronto harbor improvement (which was outlined in part in *The Canadian Engineer* for November 21st, 1912), Mr. Cousins announced some interesting points that have lately developed in connection with the scheme.

AMERICAN CONCRETE INSTITUTE.

The 10th annual convention of the American Concrete Institute, the new name adopted last July by the National Association of Cement Users, was held in Chicago, February 16th to 20th. Between 150 and 200 members and guests were in attendance. The annual Chicago Cement Show, which was held February 12th to 21st, in conjunction with the Convention and also with the Conference on Concrete Road Building made Chicago a rendezvous for road builders and manufacturers of cement and road building machinery to such an extent that the broadening use of concrete was strongly reflected in many ways.

A review of the technical committee reports and papers presented at the annual convention will be published in an early issue of this journal.

ILLINOIS WATER SUPPLY ASSOCIATION.

The sixth annual meeting of the Illinois Water Supply Association was held at the University of Illinois, March 9th to 11th. The subjects covered by addresses and reports were broad and included practically every phase of the problem of obtaining and conserving an abundant supply of pure water for the towns and cities of the State.

Among the papers which were read might be mentioned the following:—Removal of Anchor Ice by Means of Air; Remodeled Underdrain System for a Mechanical Filter Plant; Water Treatment for Railroads; Underground Movement of Contamination; Locating Leaks in Water Mains by Means of Water Hammer; the Use of the Nitrite Test in Determining the Source of Pollution of a Water Supply; the Addition of Inorganic Salts to Culture Media Employed in Water Analysis; Public Control of Water Supplies in Illinois; Rates and their Relations to Meters; Surface Water Supplies of Illinois; Value of Mathematics in Economic Design of Some Water Works Detail; Relations of Out-of-Pocket Cost to Rate-Making; Necessity for State Supervision of Water Purification Plants; and others.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

AMERICAN SOCIETY FOR TESTING MATERIALS. —Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

PERSONALS.

H. DOUGHTY, superintendent of the Regina Municipal Street Railway, has submitted his resignation to the City Council, to take effect April 30th.

It was announced in these columns recently that GEO. D. MACKIE had been appointed city engineer of Moose Jaw. His correct official title is Engineer Commissioner.

PROF. J. ANSEL BROOKS, of Brown University, on March 2nd, delivered an illustrated lecture on "The Principles of Efficiency Engineering Applied to Highway Engineering," before the Graduate Students in Highway Engineering at Columbia University.

MAJOR W. W. CROSBY, M.Am.Soc.C.E., Chief Engineer, Maryland Geological and Economic Survey and Consulting Engineer, Baltimore, Md., on February 28th delivered an illustrated lecture on "The Value of Cost Data in Highway Engineering," before the Graduate Students in Highway Engineering at Columbia University.

FILIBERT ROTH, Dean of Forestry at the University of Michigan, addressed a meeting of the University of Toronto Foresters' Club, on March 5th. Prof. Roth was born in Germany, but came to America over 40 years ago. Since then he has seen almost every phase of life on the ranch and in woods, city and university. His forest school is now the largest in America.

ROBERT W. ANGUS, Professor of Mechanical Engineering, University of Toronto, delivered a lecture on the proposed Victoria Park water supply scheme for the City of Toronto, to a meeting of the Engineering Society of the University, on Monday, March 9th. The scheme, in connection with which Prof. Angus was consulting engineer to the Department of Works, was outlined in *The Canadian Engineer* for January 22nd. (Page 227-232.)

W. W. PEARSE, a prominent structural engineer of New York City, recently addressed the Ontario Association of Architects on "Structural Problems in New York Fireproof Buildings." Economical design of steel for floors, different types of fireproof floors were discussed and wind bracing and foundations analyzed. There was a special discussion on reinforced concrete and some very useful formulæ were given for the architects' use, as Mr. Pearse pointed out, Toronto and New York codes are similar in many respects.

OBITUARY.

E. R. DOE, head of a prominent Victoria contracting firm, died recently at the age of 47. Mr. Doe, formerly a native of Norway, with his brother, had undertaken and successfully completed a number of important engineering contracts in British Columbia during the past ten years. At the time of his death, he was engaged in constructing a steel bridge over Arbutus Canyon, B.C.

The Imperial Wire and Cable Co., Limited, and the Northern Electric and Manufacturing Co., Limited, have been consolidated into one company, which will be known in future as the Northern Electric Co., Limited. The new company will continue to operate without change in management.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21413—February 27—Suspending, pending investigation by the Board, tariffs of the G.T.R., Wabash R.R., Central Vermont Ry., Rutland R.R., Michigan Central R.R., and Toronto, Hamilton, and Buffalo Ry., C.P.R., and Quebec Central Ry., requiring additional railway tickets for exclusive use of drawing-rooms or compartments in sleeping or parlor cars.

21414—February 9—Approving detail plans of the subways to be constructed by the C.P.R. Forsyth Branch, in the City of Maisonneuve, namely: Desjardins St., Pie IX. Ave., Jeanne D'Arc St., D.Orleans St., Bourbonniere St., Charlemange St., Lasalle St., and Latourneux St.

21415—February 23—Relieving, for the present, the G.T.R. from providing further protection at the crossing of the 4th Con., Twp. of Raleigh, or the third public road west of Chatham station, Ontario.

21416—February 26—Authorizing the Kaministiquia Power Co. to construct the said temporary trestle and sluice way across the C.N.R. at a point 1,390 feet west of Kakabeka Falls station, Ont.

21417—February 27—Approving plan of the Edmonton, Dunvegan and B.C. Ry. showing design for fifty-foot half-deck plate girder span of bridge to be constructed over the Athabasca River, at mileage 131 west of Edmonton, Alta.

General Order No. 121—Rescinding General Order No. 109, as from March 1st, 1914.

21418—February 14—Authorizing the C.P.R. to construct, maintain and operate a branch line of railway, or spur, on Harbor Quay, town of Goderich, Co. Huron, Ont., at mileage 111.8 on the C.P.R. Guelph and Goderich Subdivision.

21419—February 24—Amending Order No. 20817 by adding the following words after the words, "It is ordered that," in the first line of the operative part of Order, namely: "subject to the condition that the Applicant consent to accepting a new notice offering $600 instead of $1,200."

21420—February 27—Authorizing the C.L.O. & W. to construct bridge No. 88.0 aross the Trent River, Trenton, Ont.

21421—February 27—Authorizing the Esquimalt and Nanaimo Ry. to construct its railway across the railway of the Anderson Logging Co., near mileage 33 of the extension of the E. & N. Ry., from McBridge Junction to Courtenay; said crossing to be protected by an interlocking plant.

21422—February 26—Amending Order No. 21137 by striking out the words, "men appointed by the G.T.R." after the the word "operated" in the third paragraph of the operative part of the Order, and substituting therefor the words, "by the train crew of the G.T.R. Co."

21423—February 28—Authorizing the C.P.R. to use and operate bridges Nos. 15.69 and 103.7 on its line of railway.

21424—February 28—Authorizing the C.P.R. to construct, by means of grade crossings, the tracks of its Bassano Easterly Branch across road allowances between Sec. 6, Twp. 22, Rge. 3, W. 4 M., and Sec. 31, Twp. 21, Rge. 3, W. 4 M., at mileage 97.8, and between Secs. 28 and 29, Twp. 21, Rge. 4, W. 4 M., at mileage 92.8.

21425—February 27—Authorizing the C.P.R. to construct, maintain and operate branch line of railway or spur in lane in Block 200, town of Swift Current, Sask., to serve premises of John J. Perrigo and Calgary Brewing Co., situate in Subdivision, Lots 7, 8 and 9, in said Block 200.

21426—February 27—Authorizing the C.P.R. to construct, maintain, and operate a branch line of railway, or spur from a point on existing spur in lane in Block 69, thence across Subdivision Lots 7, 8, 9, 10 and 11 of Block 69, Calgary, Alta., to and into premises of Crown Feed and Produce Co., situate in Subdiv. Lots 7, 8, 9, and 10 in said Block 69, on C.P.R. main line, Alta. Div.

21427—February 27—Rescinding Order No. 20407, in so far as it directs a crossing at the west boundary of M. W. Smith's farm.

21428—February 27—Amending Order No. 19546 by striking out paragraph 3 of the operative part of the Order and substituting therefor the following:—

> "3. That the normal position of signals on both lines be at 'danger,' except between the hours of 1 a.m. and 6 a.m., during which period the normal position of signals shall be at 'clear' for the Toronto, Hamilton and Buffalo Railway Company, and at 'danger' for the Applicant Company; and that in the movements of trains of the same or of a superior class over the said crossing, trains of the Toronto, Hamilton and Buffalo Railway Company have priority at all times."

21429—March 2—Extending until the 31st May, 1914, the time within which G.T.R. are to construct and complete siding to and into premises of the Harris Abattoir Co., in Lot 10, Con. 1, Twp. Barton, Hamilton, Ont.

21430—February 24—Approving agreement between Bell Telephone Co. and the Municipal Corporation of the Twp. of Waterloo, dated Feb. 7th, 1914.

21431—February 28—Ordering the G.T.R. to stop its train No. 69 on flag signal at Glanford Station, Ont.

21432—March 2—Amending Order 21310, by inserting between the word Section and the figure 6 the following figure and words, "5 and the Northeast Boundary of Section, in the recital and operative parts of the Order.

21433—March 2—Authorizing the C.P.R. to use and operate bridges Nos. 90.2, 60.6, 63.3 and 0.3 on its line of railway.

21434—March 3—Rescinding Order No. 21402, in so far as it suspends Sup. No. 40 to the C.P.R. Tariff C.R.C. No. E-2353; directing that Sup. No. 44 to the C.P.R. Tariff No. E-2353, be lawfully in effect from and including Feb. 25th, 1914.

21435—March 3—Authorizing the C.P.R. to construct road diversion in Section 3, Twp. 23, Rge. 28, W. 3 M., Sask.; and to construct the tracks of its Swift Current Northwesterly Branch Line across such diversion at mileage 101.07.

21436—March 3—Ordering the C.P.R. to appoint and maintain a station agent at Ralph, Sask.

21437—March 3—Authorizing the C.P.R. to construct, maintain and operate extension to trackage for the Crown Grain Co., Limited, Winnipeg, Man., from a point on existing spur of the C.P.R. in Block G, St. Boniface, Man., on the C.P.R. main line, Manitoba Division.

21438—March 3—Relieving for the present the G.T.R. from providing further protection at the crossing of Main St., just east of Thorndale Station, Ont.

21439—March 3—Granting leave, subject to terms and conditions contained in said by-laws, to the Hamilton St. Railway to cross with its tracks, at rail level, the tracks of the G.T.R. (Northern and Northwestern Div.), and the tracks of the Hamilton Radial Electric Ry. on Kenilworth Ave., in the Twp. of Barton, Co. Wentworth, Ont.

21440—March 3—Ordering the American Express Co. to put in a twenty-three (23) cent rate from Springfield to Hamilton, Ont.; said rate to become effective not later than April 3rd, 1914.

General Order No. 122—Rescinding General Order No. 116, dated December 24th, 1913.

21441—March 3—Establishing collection and delivery limits of the Express Companies in the city of Edmonton, Alta.; and rescinding Order No. 20972, dated Oct. 31st, 1913.

Volume 26 Toronto, March 19, 1914

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

LONGITUDINAL RAILWAY OF CHILI

A DESCRIPTION OF THE BUILDING OF THE NORTHERN SECTION—A 450-MILE LINE THROUGH THE CHILIAN DESERT FOR PURPOSES OF PROTECTION AND DEFENCE.

By **E. H. DRURY, M. Can. Soc. C.E., M. Am. Soc. C.E.,**
Consulting Engineer, Ottawa, Ont.

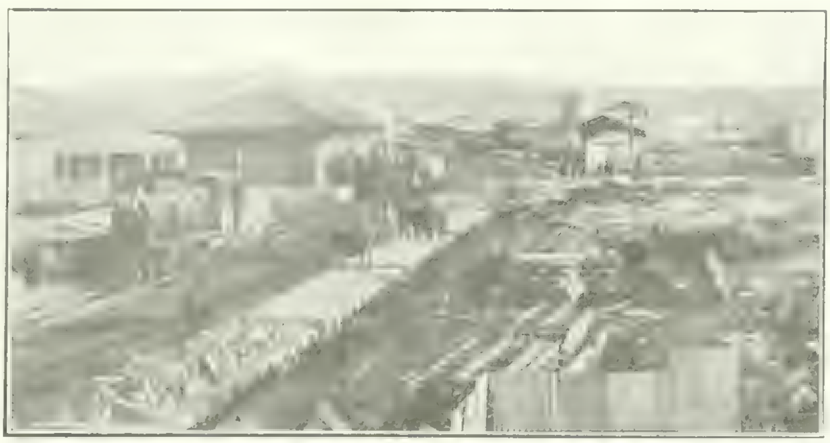
CHILI has long been the most powerful naval republic of any of the South American independencies. After the war of 1879, however, when Peru and Bolivia were despoiled of their territory by right of conquest, which included the vast nitrate beds of the Tarapaca Pampa, it was thought by the Chilian Government and politicians that it would be well to construct a longitudinal railway so that troops could be moved by land to protect their valuable acquisitions, if in the event of war the control of the sea was lost.

In the year 1888 the then Chilian Government, under the presidency of the late Don Jose M. Balmaceda, brought the issue into prominence by advertising the concession for the building of this railway, and among the contractors seeking the concession was the firm of Ross, Holt, Mann and Mackenzie, Sir Donald Mann and Mr. Holt going to Chili and entering into negotiations for the building of the road. But when everything was ready for the signatures of the contractors, the revolution of 1889 came into existence, and after fierce fighting at Santiago and Valpariso the Balmaceda Government was defeated and deposed, thus delaying the longitudinal railway enterprise for some years to come. It did not materialize again until it was carried into practical effect by the late President Don Pedro Montt, who, considering the railway essential to the welfare and development of the country, never rested until a contract was signed for the building of the north and south sections from Serano to Pintados, a distance of some 700 miles. The northern section was first to be signed and is dated 23rd April, 1910. This contract covers the ground from Pueblo Hundido (which is one of the inland stations of the Chanaral Railway) to Pintados, on the main line of the Iquique Nitrate Ry., a distance of 450 miles. This concession was originally granted to the Chilian Construction Co., Limited, who later transferred their rights to the Chilian Northern Ry. Company, the present holders, and who entered into a contract for the carrying out of the work with Messrs. Macdonald, Gibbs and Macdougall, Engineers and Contractors, New Broad Street, London, Eng.

A Cut Near Pueblo Hundido.

For the purpose of convenience in the construction of the line, this firm decided to divide the work into six sections, each section being connected by railway from the coast, thereby giving a route for the transportation of supplies and material to the work. The sections were as shown in Table I.

It is worthy of note that of all the railways enumerated in Table I. the only one which is of the same gauge as the longitudinal railway, viz., one metre (39.37 inches), is the state-owned Chanaral Ry., the others varying from 2 ft. 6 in. to 4 ft. 8½ in., which involves transshipment at the point of junction in order to reach the ports. The country through which the road was built being a desert, nothing was indigeneous to the soil. All material, supplies, plant, etc., was imported either from England, Canada, Germany or the United States. Chanaral [illegible] the



Catalina Station and Yard.

only port at which rolling stock could be landed from steamers, set up and taken direct to the work ready for service. At all other points, engines, cars, etc., were taken in piece-meal and erected at the different material yards established at the junction points by the firm.

Work was first started at El Toco in January, 1911, and the Baquedano section was commenced a week or two later, with the result that the first official train ran from Baquedano station to Toco station on the 16th September, 1911, thus forming an interior connecting link between the ports of Antofagasta and Tocopilla. The line between these points passes over the rich nitrate pampa of Tocopilla, from which industry the railway will derive the largest portion of its freight and passenger revenue.

Typical View of Country and Nature of Work.

The Aguas Blancas section was next attacked, and in rapid succession the Pintados, Catalina, and Pueblo Hundido followed. In July, 1913, the rails were joined from the north and south and by November, 1913, the whole of the line was completed and handed over to the original concessionaires. Thus in two years and ten

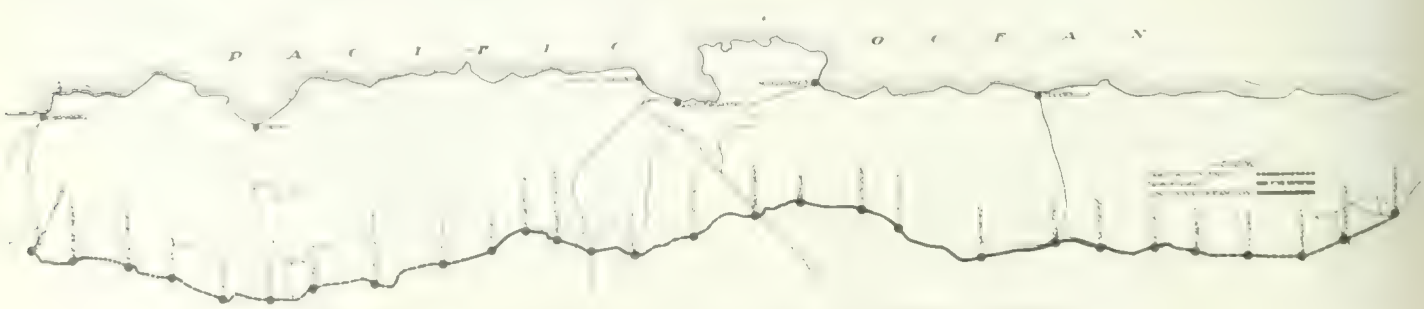
Pintados Yard and Station.

months the total distance of 450 miles of railway was graded, track laid, telegraph lines, tanks, stations, freight sheds, round-houses, work shops, machine shops, car sheds and turntables were erected; and all rolling stock necessary for the equipment of the road delivered and set up ready for operating. The rolling stock included sleepers, diners, 1st, 2nd and 3rd class passenger cars, flats, boxes, open boxes, cattle cars, powder vans, tank cars and 27 engines of different classes. This record for railway building in Chili is absolutely unprecedented.

Table I.

Pueblo Hundido (Junction with Chanaral Ry. northward to Altimira)	50 miles
Altimira northward to Catalina (Junction with Taltal Ry.)	44 "
Catalina northward to Aguas Blancas (Junction with Aguas Blancas Ry.)	81 "
Aguas Blancas northward to Baquedano (Junction with Antofagasta and Bolivia Ry.)	70 "
Baquedano northward to El Toco (Junction with Tocopilla Ry.)	98 "
El Toco northward to Pintados (Junction with Iquique Ry.)	107 "
Total	450 miles

The work was accepted by the Government in sections of 75 miles. Corresponding decrees were issued guaranteeing payment of interest and amortization on the value of these sections as provided by the contract. Based upon these decrees bonds have been successfully issued in London. The contract was to have been completed in April, 1914, and was therefore finished five



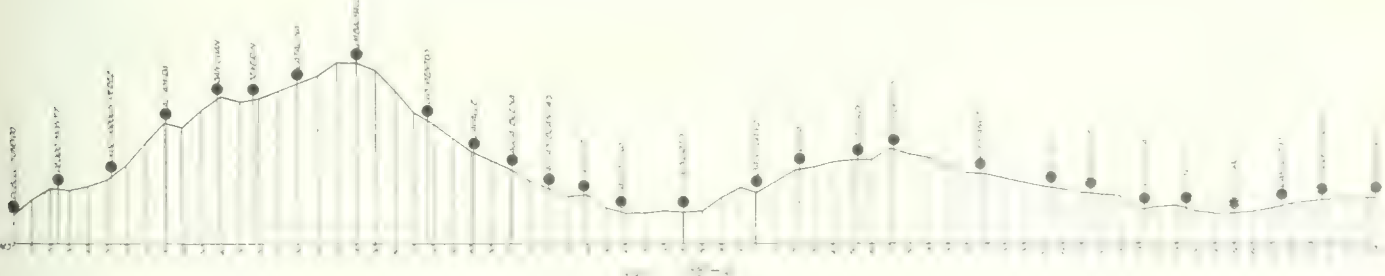
General Plan of Northern Section, Chilian Longitudinal Railway.

months before date of expiry. Thus by the completion of the Northern section the whole of the great Chilian nitrate districts are now connected by rail with Santiago, Valpariso and Port Montt, the total length of the system being 1,600 miles.

The northern section is built across the great Chilian desert on which for the whole distance of 450 miles one cannot find a blade of grass or a living insect. In fact, it is absolutely devoid of life. Darwin, in his travels, which included the Chilian desert, states: "It is the most perfect desert in the world."

In building the line, the water question was one of the most serious problems, but by hard work in drilling the contractors were eventually rewarded, and secured a good supply from wells at different points on the line. In some places it was found necessary to erect condensers as the only water obtainable was salt. These plants yielded a supply of 15,000 gallons per day, and gave excellent satisfaction. At some of the wells, owing to the hardness of the water it was necessary to erect softeners, the water first passing through chemicals then to the tank for engine supply. During construction water was often hauled 60 miles in order to supply the workmen doing the grading. The labor employed was native, and a better class of railroaders would be hard to find, from five to seven thousand being constantly employed.

Baquedano Yard, Showing Car and Engine Sheds.



Profile of Route of Northern Section.

As nothing grew in the country, all supplies of every sort and description were imported, the majority of the ties, telegraph poles and timber for stations, etc., were obtained in British Columbia, although a few ties, etc., came from Southern Chili. The stations were constructed with timber frame covered with corrugated iron; matched board partitions. This was the rule with all buildings except the main machine shops at Baquedano which were of steel frame covered with corrugated iron. Tanks and softeners were of steel, with steel frame on concrete foundations.

There was only one bridge on the whole line, this being at Quillagua, across the Loa River valley. As it never rains in the country there are no streams to cross.

As the sections were accepted by the Government, and the decree issued, the contractors were obliged to operate these accepted sections. Before the final acceptance of the whole line the contractors were operating 250 miles, on which a large traffic in the haulage of nitrate and supplies to the different nitrate plants along the line was developed. During an outbreak of yellow fever in the port of Tocopilla in the summer of 1912, the road was able to maintain the traffic between the ports of Tocopilla and Antofagasta by the interior connecting link, thus saving thousands of pounds in keeping the many nitrate plants in supplies, thereby avoiding their closing down during the epidemic. Up to this date all supplies had been shipped to Tocopilla by sea and then to the Pampa by the Tocopilla Railway. As the port was in quarantine during the epidemic, ships were not allowed to enter or leave.

The whole of the work was under the supervision of the Chief Government Engineer, Sr. Augusto Knudsen, who spared no pains to see that the work was well and properly done. The chief engineer for the concessionaires was Mr. W. B. Leane, A.M.I.C.E., with headquarters at Santiago. The headquarters of the contractors, Messrs. Macdonald, Gibbs and Macdougal, was in Antofagasta, the chief sea port of Northern Chili. Here they employed a large staff, the heads of the different departments being either English or Canadian. The whole work was under the direct control of the general manager. The partners, Messrs. Arthur C. Macdonald, a Nova Scotian by birth and a graduate of the Royal Military

College of Canada, and Edward T. N. Macdougal, are both well-known engineers and contractors in London and Chili. In the latter country they have carried a number of large and important works to a successful finish.

To more fully give a comprehensive idea of this undertaking, a map is given of the route showing connections with the coast ports, a grade profile showing altitudes which vary from 3,250 to 7,852 feet above the sea, and a number of photographs illustrative of the buildings, nature of work and country through which the railway passes.

INTERNATIONAL ENGINEERING CONGRESS, 1915

Rapid progress is being made in working out the final programme of papers for the International Engineering Congress to be held in San Francisco in 1915.

The first volume of the publication of the Congress will consist of a series of articles descriptive of the various technical features of the design and construction of the Panama Canal. The various topics which will be treated are noted in the following list:—

(1) Introductory Chapter.
(2) Dry Excavation for the Panama Canal.
(3) Dredging in the Panama Canal.
(4) Terminal Works, Dry Docks, and Wharves of the Panama Canal.
(4) Permanent Shops of the Panama Canal.
(6) Coaling Plants and Floating Cranes of the Panama Canal.
(7) Meteorology and Hydrology of the Panama Canal.
(8) Design of Locks, Dams, and Regulating Works of the Panama Canal.
(9) Method of Construction of the Locks, Dams, and Regulating Works in the Atlantic Division of the Panama Canal.
(10) Method of Construction of the Locks, Dams, and Regulating Works in the Pacific Division of the Panama Canal.
(11) Design of Lock Walls and Valves for the Panama Canal.
(12) Design of the Spillways on the Panama Canal.
(13) Gates of the Panama Canal Locks.
(14) Electrical and Mechanical Installations of the Panama Canal.
(15) Emergency Dams above Locks of Panama Canal.
(16) Municipal Engineering and Domestic Water Supply in the Canal Zone.
(17) Reconstruction of the Panama Railroad.
(18) Aids to Navigation of the Panama Canal.
(19) Geology of the Panama Canal Zone.
(20) The Working Force of the Panama Canal.
(21) Sanitation in the Panama Canal Zone.
(22) Purchase of Supplies for the Panama Canal.

Each of these topics will be treated by someone on the canal force who has been responsible for the design and construction described. The introductory chapter as well as the topic of Dry Excavation for the Panama Canal will be handled by Colonel Goethals himself.

The programme of papers for the various sections of the Congress is practically completed and notices of them will be published in the near future.

Buoys of reinforced concrete built for Kingston, Jamaica, weigh each about 5 tons, carry about one ton of ballast, and are said to cost a little less than half as much as steel buoys of the same size. The buoys are cylindrical in shape, with the bottom concaved to give protection to the mooring chain eye bolt. The sides have curved horizontal ribs, with bottom reinforced bars built up inside the shell, and waterproof cement on the outside and inside builds up [illegible]. The top is a solid slab, with reinforcement extended down the side. A temporary manhole serves for removing the interior centring and for convenience in lowering; but its cover is sealed in place when the work is finished. As water sometimes leaks [illegible] a pump hole with brass screw cap is provided.

COAL AND COKE PRODUCTION IN 1913.

THE coal mining industry in Canada in 1913 was marked by an increased production in the Maritime provinces of Nova Scotia and New Brunswick and in the Province of Alberta and a falling off in the provinces of Saskatchewan and British Columbia. In the latter province the decrease was entirely due to the continuance throughout the year of the labor strike in the mines on Vancouver Island. The lessened production in these two provinces was, however, more than offset by the increased output in Alberta and Nova Scotia so that the net result for the year was an increase of about 602,260 tons or 4.15 per cent.

The total production of marketable coal for the year comprising sales and shipments, colliery consumption and coal used in making coke, etc., was 15,115,089 short tons, valued at $36,250,311, as against 14,512,829 tons, valued at $36,019,044, in 1912. Nova Scotia shows an increase of 188,839 tons, or 2.4 per cent.; Alberta an increase of 903,800 tons, or 27.9 per cent.; Saskatchewan a decrease of 16,167 tons, or 7.1 per cent., and British Columbia a decrease of 494,548 tons, or 15.4 per cent. The figures for the Yukon represent for 1913 the production from the Tantalus field only, no record having as yet been received of the output below Dawson.

The production by provinces during the past three years, as given in a recent preliminary report by John McLeish, B.A., of the Division of Mineral Resources and Statistics, Canada, is shown in Table I.

Table I.—Production of Coal by Provinces.

Province.	Tons.	Value.
	—1911—	
Nova Scotia	7,004,420	$14,071,379
British Columbia	2,542,532	7,945,413
Alberta	1,511,036	3,979,264
Saskatchewan	206,779	347,248
New Brunswick	55,781	111,562
Yukon Territory	2,840	12,780
Total	11,323,388	$26,467,646
	—1912—	
Nova Scotia	7,783,888	$17,374,750
British Columbia	3,208,997	10,028,116
Alberta	3,240,577	8,113,525
Saskatchewan	225,342	368,135
New Brunswick	44,780	89,560
Yukon Territory	9,245	44,958
Total	14,512,829	$36,019,044
	—1913—	
Nova Scotia	7,972,727	$17,796,265
British Columbia	2,714,449	8,482,653
Alberta	4,144,377	9,462,836
Saskatchewan	209,175	347,685
New Brunswick	70,311	140,622
Yukon Territory	4,050	20,250
Total	15,115,089	$36,250,311

The exports of coal in 1913 were 1,562,020 tons, valued at $3,961,351, as compared with exports of 2,127,133 tons, valued at $5,821,593, in 1912, a falling off of 565,113 tons or over 26 per cent.

Imports of coal during the year included bituminous, round, and run of mine 10,743,473 tons, valued at $21,756,658; bituminous slack, 2,816,423 tons, valued at

$4,157,622; and anthracite, 4,642,057 tons, valued at $22,034,839; or a total of 18,201,953 tons, valued at $47,949,119.

The imports in 1912 were, bituminous, run of mine, 8,491,840 tons, valued at $16,846,727; bituminous slack, 1,915,993 tons, valued at $2,550,992, and anthracite, 4,184,017 tons, valued at $20,080,388, or a total of 14,595,810 tons, valued at $39,478,037.

Thus the increase of imports of coal in 1913 amounted to a total of 3,606,143 tons, or nearly 25 per cent. The increase in the imports of bituminous run of mine being 2,251,633 tons, or 26.5 per cent., increased imports of slack 900,430 tons or 47 per cent., increased imports of anthracite 458,040 tons or 11 per cent.

The apparent consumption of coal during the year was 31,685,456 tons as against a consumption of 26,934,800 tons in 1912. Of the consumption in 1913 about 42.8 per cent. was from Canadian mines and 57.2 per cent imported.

Coke.—The total output of oven coke during 1913 was 1,517,133 tons of 2,000 lbs., made from 2,147,913 tons of coal of which 1,598,912 tons were mined in Canada and 549,001 tons imported. The total quantity of coke sold or used by the producers during the year was 1,530,499 tons, valued at $5,547,694.

In 1912 the total output was 1,406,028 tons and the quantity sold or used by the producers 1,411,229, valued at $5,164,331.

The output by provinces in 1913 was: Nova Scotia, 920,526 tons; Ontario, 411,643 tons; Alberta, 65,104 tons, and British Columbia, 319,860 tons. That of Ontario was entirely from imported coal.

By-products from coke ovens recovered during the year included 10,608 tons ammonia sulphate; 8,371,600 gallons of tar and 3,353,731 thousand feet of gas, and the total value would approximate $866,150.

The ovens of the Acadia Coal Co. and Londonderry Iron and Mining Co. in Nova Scotia, the Atikokan Iron Co. in Ontario, the West Canadian Collieries and Leitch Collieries in Alberta and the Canadian Collieries, Limited, in British Columbia were idle throughout the year. At the end of the year there were 1,720 ovens in operation and 1,325 idle as follows: Nova Scotia, 572 active, 376 idle; Ontario, 110 active, 100 idle; Alberta, 134 active, 233 idle; British Columbia, 904 active, 426 idle.

The exports of coke during 1913 were 68,235 tons, valued at $308,410, and the imports 723,906 tons, valued at $2,180,830. In 1912 the exports were 57,744 tons, valued at $252,763 and the imports 628,174 tons, valued at $1,702,856.

Messrs. Ohrt and Ouistgoord, Danish engineers, have prepared plans and an estimate of cost for a submarine channel tunnel to connect Denmark and Sweden. According to the plans, the railway will be carried along the coast south from Copenhagen on an embankment, and the first part of the tunnel will be under the "Drodg," as that part of the Sound is called which lies between the mainland and the little island of Saltholm. The railway will run across the island above ground and then dip under the Sound again, till it reaches the west coast of the Swedish province of Schonen. The end of the tunnel will be at Limuhamm, which is a little to the south of Malmo. The entire length of the new railway will be about 30 miles, of which nearly 9 will be submarine tunnel. The greatest depth at which the tunnel will run will be about 100 feet, and it is estimated that the undertaking can be completed in 5 years at the cost of about $25,000,000. The tunnel will be worked by electricity, and will have to be driven through the same kind of stratum, grey chalk, as would the tunnel between England and France.

ORGANIZATION AND METHODS OF STREET CLEANING DEPARTMENTS.*

By **William H. Connell,**
Chief, Bureau of Highways and Street Cleaning, Philadelphia.

THE organization and methods of street cleaning is a comparatively new field for the engineer, and in this respect it differs from the other branches of highway engineering, such as the construction and repair of pavements, which have always been—at least in some localities—more or less under the jurisdiction of the engineer, even though only considered seriously by the engineering profession and the public within the last few years. The construction, maintenance and care of pavements is distinctly a highway engineering problem, and the cleaning of the pavements is a part of this work, and the highest point of efficiency will never be reached until it is so recognized.

We all agree that ease of operation is the most important factor to be considered in any organization, and this cannot be accomplished without centralizing the control of all the functions so closely related and interrelated with respect to the different branches of the work that there is bound to be an overlapping of jurisdiction and a certain amount of duplication of work and lost effort if under separate organizations. This is the case where highway and street cleaning work are under separate control, and it is for this, aside from many other reasons, that the cleaning of streets is properly a function of the organization having jurisdiction over the construction and maintenance of the highways. It is obvious, from a business and engineering point of view, that the logical way to handle both of these branches of highway work, in order to attain the greatest economy and efficiency, is through one organization, which would properly be the highway department. Unfortunately, most of the discussions and papers written relating to highway and street cleaning organizations have been confined to an outline of the methods of carrying on the work of existing organizations. A careful review of the ground covered in these articles forcibly suggests that the field cannot be economically and properly covered through separate departments, and that the inevitable solution is the one organization controlling all the branches of the work relating to the highways.

A proper highway engineering organization, composed of a personnel capable of controlling such work, would also be equipped to handle the collection and disposal of ashes, garbage and waste with far less additional expense than through a separate organization, and, as the ashes and rubbish should be collected previous to cleaning the streets, each cleaning and collection schedule bears a relation to the other, and, therefore, the line of least resistance would be to carry on both branches of the work through the one organization.

In Europe, street cleaning work is more generally under the supervision of the engineers than in this country, and it is usually under the control of a department having jurisdiction over the construction and maintenance of the pavements.

In Paris, the street cleaning authorities are charged with the construction and maintenance of streets and sidewalks, as well as with sweeping the streets and sidewalks, sprinkling roadways, collecting house refuse and

* Lecture delivered by Mr. William H. Connell before the Graduate Students in Highway Engineering at Columbia University on January 15th, 1914.

removing dirt, ice, and snow from the streets. The work is done by a branch of the Department of Public Works and is under engineering supervision.

In New York there is a street cleaning department having charge of the street cleaning, removal of snow, collection and disposal of ashes, garbage and rubbish, in the Boroughs of Manhattan, Bronx and Brooklyn. In each of these Boroughs there is a separate department having charge of the construction and maintenance of highways. In the Boroughs of Richmond and Queens the street cleaning, collection and disposal of ashes, garbage and rubbish come under the jurisdiction of the Department of Public Works, as does the construction and maintenance of highways.

In Chicago, the Bureau of Streets embraces street cleaning, collection of ashes, garbage and refuse, the removal of snow, and also street repairs, but not the construction of pavements.

The St. Louis Street Department embraces the construction and maintenance of streets, street cleaning, collection and disposal of ashes, garbage and refuse, and the removal of snow.

In Washington, the street department has jurisdiction over the construction and maintenance of streets, street cleaning, collection of ashes, garbage and refuse, and the removal of snow.

In Philadelphia, the Bureau of Highways has control over the construction and maintenance of streets, street cleaning, collection and disposal of ashes, garbage and refuse, and the removal of snow.

The above mentioned departments also have jurisdiction over other matters which are aside from the subject of this paper and will not be taken up, the object being, first, to point out the necessity for placing street cleaning work, including the removal of ashes, garbage and refuse, etc., under engineering supervision, and second, to combine this work with the general highway work. Of the cities mentioned the New York street cleaning organization—although second only from a point of efficiency to that of Washington—is founded on the wrong principle, inasmuch as it has not been an engineering department and is under separate control from the departments having jurisdiction over the construction and the maintenance of highways. The ideal organization for New York City would be somewhat along the following lines:—

The Bureau of Highways to have jurisdiction over the construction and maintenance of highways and street cleaning for the whole city. This would result in more uniform methods and more efficiency and economy in carrying on the work than exists under separate organizations, each working independently of the others. Of course, each Borough should have a voice in the management, probably through an Engineering Commission, somewhat on the order of the Board of Estimate, but the methods of carrying on both of these branches of highway work should be uniform in all of the Boroughs. New York has been selected to show the absence of engineering supervision in street cleaning and co-operation in both of these important branches of municipal work, simply because it is more in the public eye than any other city, and the generally accepted theory that one central body should control, so far as is possible, any one particular line of work, such as highways and street cleaning, has not been put into effect, even in this progressive municipality.

Cost of Cleaning Different Types of Pavements.—We cannot divorce the construction from the maintenance and care of the pavements, as the fundamental principles that should govern the selection and design of a pavement must necessarily take into consideration, amongst other things, the cost of the maintenance and its desirability from a sanitary point of view; and obviously in this connection the character and cost of street cleaning is a most important factor, as the welfare of the community must be considered, for dirty pavements are not only a great annoyance, but they spread disease, and no stone should be left unturned to combat this evil.

Aside from the financial, which is the first and most important consideration in any undertaking, the two basic principles that should govern the selection of a pavement are the traffic and sanitary requirements. Under these headings the gradient, first cost, cost of maintenance, noiselessness, social and local conditions, street cleaning, etc., may be grouped. In determining upon the proper pavement for the vast majority of streets in our municipalities, we should assume that the public health of the community demands that the pavements be kept clean. Therefore, the cost of cleaning during the life of the pavement is one of the primary considerations, and where the traffic conditions, aside from reasons due to gradient, might call for a stone block pavement, the cost of cleaning during its probable life might make it not only desirable but more economical to substitute an asphalt pavement on account of the lesser cost of cleaning. There is practically no definite data on this subject, but the following quotations from the report of a committee appointed in 1907 by the Mayor of New York City to investigate street cleaning methods, and from the Superintendents' Handbook on Cleansing, by Arthur May, Superintendent of Cleansing in the Metropolitan Borough of Finsbury, London, give a very good idea of the possibilities and value of collating reliable data along these lines for use in computing the cost of the maintenance and care of the pavements.

The following is quoted from the report of the New York Commission:—

"There is a very marked difference between the quantity of dust left upon the pavements of various kinds. Thus, if we call the average volume and weight collected from the sheet asphalt pavements 100, the relative quantities from other kinds of pavements were:—

	Volume.	Weight.
From sheet asphalt	100	100
From block asphalt	130	182
From wood block *	332	145
From granite block	1,081	912

After careful consideration of all the facts available, we estimate the average relative cost of cleaning, equally well, the various kinds of pavements in use in the city under similar conditions of repair as follows:—

Sheet asphalt pavement	100
Wood block pavement (new)	105
Asphalt block pavement........................	115
Brick pavement	120
Wood block pavement (old)	125
Medina block pavement	130
Granite block pavement	140
Belgian block pavement	150
Cobblestone pavement	3,000

On the assumption of 100 cleanings per year, it may be shown that the annual cost of cleaning equally well

* It should be said that the wood block pavement on which the examination was made is one of the oldest of its kind in the city, and its surface, being uneven, caught and held an uneven quantity of dust. Wood block pavement, when comparatively new, should compare favorably with asphalt block pavement in its freedom from dust-retaining qualities.

a mile of each of the pavements named over what it would be if sheet asphalt were substituted, would be as follows:

Wood block pavement (new)	$ 26.40
Asphalt block pavement (average condition)	79.20
Brick pavement	105.60
Wood block pavement (old)	132.60
Medina block pavement	158.40
Granite block pavement	211.20
Belgian block pavement	264.00
Cobblestone pavement	1,584.00

In speaking of the pavements of London, Mr. May says:—

"The four types of carriage-way pavings that are in general use are asphalt, wood, granite and other stone sets, and macadam. The order in which they are placed is, to all intents and purposes, the degree in which they lend themselves for cleansing, and, although the difference between the first three is not very great, there is no doubt that from a cleansing point of view, asphalt supercedes all others.

The following figures will give some idea of the relative cost per yard of cleansing the four kinds of road surfaces: Asphalt, 12 cents; wood, 76 cents; granite, 83 cents; macadam, $3.

"The above figures represent the cost per annum for the scavenging of one square yard of such roadway under equal conditions.

"It has been found that for every eight loads of slop removed from macadam roads, two loads are removed from granite sets, one and a half loads from wood paving, and half a load from asphalt."

If street cleaning had been more generally under the control of highway engineering organizations it is probable that we would be in possession of more definite data relating to this fixed charge in connection with the maintenance of our pavements.

Day Labor vs. Contract System.—There is one point in connection with street cleaning work that is generally agreed upon, both in this country and abroad, namely, the work involves so much detail, for which there are no definite units, that it can be more economically and better done by labor employed directly by the municipality than by the contract system. Philadelphia is the only one of the twenty-five largest municipalities in this country where the contract system is employed, and in this municipality the excessive inspection charge for the supervision of the work, aside from the fact that the work could be carried on more efficiently by day labor, is sufficient argument for municipal operation.

Uniforming Employees.—It also appears to be generally accepted that the street cleaning forces should be in uniform, and this is the case in the twenty-five largest municipalities in this country. In this respect it is singular that about nineteen years ago, when Col. Waring put the New York street cleaning force in uniform and established a more or less military organization, he was ridiculed by all the local newspapers and a number of others throughout the country. The wisdom of the step taken by Col. Waring, however, is generally appreciated to-day, as it is necessary to have a more or less military organization in connection with work of this character, and the uniforming of the force not only makes the men more conspicuous and permits the public to act as self-constituted inspectors, but raises the standard of the work and has the moral effect of increasing the efficiency through the pride the men take in the work.

Sources of Street Dirt.—Before going into the methods of street cleaning, it will be advisable to consider the origin and volume of street dirt, which is derived from a number of different sources, the principal ones of which may be summarized under the following headings:—

1. The excrement of animals.
2. Material lost by passing vehicles.
3. Dirt swept from sidewalks and thrown from buildings into the street.
4. Dirt from unpaved streets and alleys.
5. Falling leaves.
6. Building construction.
7. Soot and dust from the air.
8. Material originating from the wear of pavements.
9. Dirt due to scavengers picking over refuse placed on the street for collection.

To give an idea of the volume of street dirt collected, the Commissioner of Street Cleaning of New York in his report for 1912 states: "In the collection of the waste for this year we have handled 2,755,897 tons of ashes and street sweepings, 210,652 tons of rubbish, and 340,815 tons of garbage, a total of 3,307,364 tons. This accumulation, if placed in City Hall Park, would completely cover that area (8 acres) with a heap whose top would reach to a height 85 feet above the top of the new Municipal Building (or about 650 feet)."

Preventive Street Cleaning.—In considering some of the principal sources of street dirt, such as material lost by passing vehicles, dirt swept from sidewalks and thrown from buildings into the street, dirt from building construction, it is very evident that our streets could be made very much more sightly and the work of street cleaning carried on at a much less cost, if we had the proper kind of co-operation from the public, as the three principal causes of street dirt just mentioned could be entirely eliminated. This brings up one of the most important problems in connection with street cleaning, which is termed "Preventive Street Cleaning," and deals with the educational and publicity work being carried on to educate the people to use the same degree of care in connection with the streets that they do in their homes.

When Col. Waring was Street Commissioner of New York City he formed leagues of school children to teach their parents the importance of refraining from throwing refuse upon the pavements. At the time this was a novel way to reach the people in connection with preventive street cleaning work, but it is generally accepted to-day as one of the best means of carrying on work of this kind, and in Philadelphia a woman is employed in the Street Cleaning Department just for the purpose of securing this kind of co-operation from the school children, Boy Scouts, and civic organizations. The results from the educational campaign that is now being carried on in the different cities throughout the country will be more in evidence when the children of to-day have grown up, as street cleaning work, conducted on a scientific basis, is comparatively new, and a number of the older people do not show the interest that the growing citizens do in this or other branches of municipal work.

It is purely an educational campaign, but, like everything else, must be backed up by the law, and will often require a few arrests for offences, such as leaky wagons, throwing paper and store sweepings into the street, etc., to drive home the importanct of living up to the laws and ordinances regulating these matters. A good example of the kind of co-operation we want in this respect occurred in Philadelphia recently, when one of the owners of a large manufacturing establishment requested the

Department to help him keep clean the streets in the vicinity of his business by arresting any of his employees found throwing paper or sweepings into the streets, or violating any of the laws or ordinances designed to help keep the streets clean.

Waste Paper Cans or Baskets.—In many of the progressive cities in this country waste paper baskets or cans have been placed at different prominent locations throughout the city. In some cases these are paid for by the city, and in others by civic organizations interested in this work.

Scavengers.—One of the greatest sources of annoyance and unnecessary littering of the streets in many of our municipalities is due to scavengers, a class of people —men, women and children—who pick over the refuse placed on the curb for collection for rags, bottles, paper and other saleable products, and whenever they have an opportunity work in the same manner on some of the public dumps. In the course of their operations they always scatter a certain amount of ashes and dirt, etc., on the street. This trouble is also a source of annoyance in European cities, although they have it more generally under control. In Paris, for instance, there are twenty to thirty thousand scavengers operating in this way. Just before the house refuse is to be collected they go along the streets, spread a square of burlap or other cloth upon the sidewalk and tip the refuse can over on it and overhaul the contents, depositing in a bag the saleable products picked out. Thus they avoid littering the streets, and this is one of the conditions under which they are allowed to operate. The city authorities, however, have apparently been unable to rid the city of them, although they are not as objectionable as they might be, due to being under control.

Standard Methods.—In so far as street cleaning is concerned there is no such thing as standard methods in this country, or, if I am correctly informed, abroad. Each city in this country until only recently has been working independently of the other cities and without profiting by their experience. The report of the Chicago Bureau of Efficiency for 1913 states, in referring to data from other American cities in connection with a very exhaustive investigation carried on relating to street cleaning matters, that: "Inquiries directed to the larger cities of the country as to the methods and systems used in the cleaning and repair of streets and alleys and the collection of municipal wastes brought forward replies from twenty-five of the larger municipalities. The analysis of the information received showed the diversity of methods and conditions and a general lack of uniformity in maintaining uniform records and standards, and it was found impossible to use the same as a basis for comparison."

Referring to the work of the Chicago Bureau of Efficiency, which has been very commendable, both in the scope of the work and the character of report submitted, one cannot help but feel that what is really needed in this country, and particularly at this time—when all our leading cities are conducting investigations relating to all the branches of public works—is an association whose principal membership would consist of the cities and Public Works Departments throughout the country, organized for the purpose of collating data which would be of value to all municipalities, and would enable one to profit by the experience of others, and establish, in so far as the fundamental principles are concerned, standards for all classes of work, subject, however, to modification from year to year through investigations of committees appointed from the different cities and Public Works Departments for this purpose. This would enable all the cities to keep abreast of the times and would result in more uniform methods in all branches of public work throughout the United States. The Association for Standardizing Paving Specifications, which was conducted along these lines, and which accomplished more real work of general value to the country at large in the short period of its existence than any other society organized for similar purposes, has been recently discontinued. This was decidedly a step backward and is to be very much regretted, as this Association was founded on the correct principle, and its work was made a part of the work of the municipalities. It would appear to have been a wiser policy to have enlarged the scope of this Association to embrace all branches of public work.

Street Cleaning Methods Abroad.—In speaking of conditions abroad, it was recently said by an engineer, who has made an extensive study of street cleaning methods, that, taking into consideration the number of years they have been at it, the cost of labor and appropriations made, it might be expected European cities would be much further advanced than they are to-day. This is borne out by the following extracts from articles on street cleaning, from which it would appear they are not as far advanced as we would be led to suppose through comments of different citizens who have visited European and continental cities.

Commenting upon street cleaning in Paris, Soper, in his book on "Modern Methods of Street Cleaning," published in 1909, states: "Paris is universally conceded to be one of the cleanest and most beautiful cities. Many of its streets have been built in accordance with wise and comprehensive plans, a fact which has contributed substantially to its successful development."

Two years later the "Surveyor" for 1911 (an English publication) stated: "The following extract from an official report shows that Paris has somewhat fallen from its lofty heights, and, while the English towns have rapidly improved, the city of Paris has quite lost its supremacy:—

"The upkeep of the streets and roadways of Paris (the correspondent of the "Times" states) costs 600,000 pounds sterling ($3,000,000), and 5,000 men are employed in this branch of the municipal service. Although it is contended by French critics, Paris spends an enormous sum—which is far more considerable in proportion than the expenditure for this purpose in other great cities —the streets of the once renowned "Ville Lumiere" have fallen into a chronic state of deplorable neglect. The reporter of the Municipal Budget, who is unsparing in his condemnation of the filthiness of Paris, attributes the evil to want of organization on the part of the responsible services. Public works are executed at haphazard, without regard for promptness or uniformity. A single roadway is torn up time after time for one purpose or another, and no attempt at co-ordination is made. With regard to the actual cleaning of the streets, M. Dausett bitterly remarks that 'When all is said and done, the rain remains the great cleanser and scavenger of the Paris streets.' "

Referring to the same subject, "Cleansing Superintendent" for 1911, also an English publication, states:—

"It is certainly singular that the Paris Municipality has suffered matters in relation to the maintenance and cleaning of the public thoroughfares to go from bad to worse. They might usefully study the methods adopted in English cities, which are rarely excelled."

And the following quotation from the "Superintendents' Handbook," by Arthur May, likewise gives

some idea of the estimation of the English of French methods:—

"Much has been written and said of the extreme cleanliness of Paris and its modern methods, yet anyone with a critical eye cannot be impressed with the puny methods employed.

"Thirty years ago Paris was no doubt to the fore, but it has apparently been standing still for some years; consequently to-day it is very much behind many other continental cities, and has a lot of headway to make if it is to compete seriously with these and the large English towns. Even their own Chief Magistrate, in his report this year, seriously deprecates the inefficient means adopted to cleanse the city, and strongly urges for a responsible department to take control of this work. Channel and gutter swilling appears to be the important feature of street cleansing. The water is obtained from hydrants placed in the footways, and these emit the water on to the outer edge of the curb, so that when turned on it runs along the gutter in the direction of the gradient. Should the flow not be sufficient a dam is made by using heavy pieces of sacking, and the same process is applied should it be desired to cause the water to flow one hundred feet a minute, gathering up enroute dust and light articles. The operation is assisted by a man with a broom, who sweeps all refuse within reach into the flowing stream.

"In summer the roads are hand-sprinkled with a 2-inch rubber hose, and to those who have watched the operation there is no doubt that the men so employed are masters in the manipulation of this hose. Generally the refuse is washed into the sewers."

From these extracts it is evident that the English consider their methods par excellence. This, however, we have often heard disputed, the general consensus of opinion being that German cities are further advanced in this branch of municipal work, which might be implied from the following description from the cleansing method in Berlin by Mr. Arthur May:—

"The city of Berlin is undoubtedly one of the most advanced in methods of street cleaning, as is also the plant in use. Modern science and education have been brought to bear in a very marked degree upon the scavenging of the city. The streets are flushed regularly by water vans, and at present they have in use a machine which undoubtedly represents the highest success yet obtained in street cleansing appliances. The machine is electrically driven, and consists of a street watering van with a machine broom behind. The water is distributed at the front and sides of the vehicle, and the whole operation of machine sweeping and street watering is accomplished by one man in one act. The delivery of water is so controlled that pressure, obtained by compressed air, may be applied in its distribution; thus street swilling and brushing may be effectively carried on even during the busiest part of the day. Many continental cities have in use a new type of apparatus in the form of a watering cart, to which is attached a rotary squeegee, fashioned somewhat after a rotary machine broom. The effect of this combination is that a street may be washed and left practically dry afterwards, the apparatus being worked by one man only."

We must, however, refrain from relying too much on these statements if we are to judge from the following quotation from the "Superintendents' Handbook," by Arthur May, referring to the street cleaning in New York:—

"Wonders may be expected from this hustling city in its street cleansing operations, yet the only factor which strikes one from the official data is that the Chief Commissioner, who is the head of the Street Cleaning Department, appears to get a salary of about $7,500 a year, and in this respect New York is certainly a shade in advance of the English capital. This official, however, only holds office so long as the Mayor for the time being holds his.

"The streets are swept by hand, by order of the authorities, and the methods adopted are somewhat ancient. A short-handled broom, a scraper and a pan-carrier are the tools used. The can is like a barrel mounted on two wheels, being upright, with an open top.

"Length-sweeping is adopted, each man being allotted a length of street from 400 feet to a mile, according to the width, and he is expected to keep this section clean. The refuse made is placed in the receptacle, or can, at other times into bags, these in their turn being emptied into vans, which ultimately deposit their loads into barges. The whole of the work is done during the day time. No water can precede the sweepers, but flushing with a hose is practised somewhat extensively, as is also swilling by the water-can.

"The refuse is tipped upon low-lying land."

At the time this book was written, New York was advanced according to present-day standards in street cleaning, and there was apparently very little difference in the methods used in New York and foreign cities, which illustrates the danger of laying too much stress on the point of view of an individual in the absence of definite data.

(To be continued.)

A most favorable report was issued in February at Montreal by the Nova Scotia Steel and Coal Company for the year ending December 31, 1913. The net earnings amounted to $1,255,155.54, being an increase of about 25 per cent. over those of 1912, and being equal to 11.14 per cent. on the outstanding capital of $6,000,000. These earnings compare with $1,000,609.93 in the previous year, which were equal to 8.43 per cent. on the capital.

The progress made in the surveying of the province of British Columbia during 1913 has established a record, according to the report of the Surveyor-General, which is included in the annual report of the Minister of Lands, presented to the Legislature recently. One million acres of crown lands have been surveyed by the Government, and the greater part of this vast area has been subdivided into lots varying from 40 to 160 acres in extent; 400 miles of district boundaries have been run; explorations have been carried out in Cassiar and Peace River districts, and a commencement has been made on the de-limitation of the eastern boundary of the province in conjunction with the Governments of the Dominion and of the province of Alberta.

The recently published report of the Surveyor-General included in the annual report of the Minister of Lands shows that in British Columbia, in the matter of private surveys, the outstanding feature of the year is the quantity of timber lands surveyed. It is probable that when all returns are received it will be found that 1,500,000 acres of land held under special timber license have been surveyed, which equals the combined area surveyed in 1911 and 1912, and amounts to, practically, 30 per cent. of the timber land held under license and unsurveyed at the beginning of the year. On the other hand, the area of land surveyed privately is under 600,000 acres, or only about 50 per cent. of that surveyed in the preceding year, the shrinkage being due to the decrease in the area of unsurveyed land held under application to purchase. The area of mineral claims surveyed is well above the average. The area of surveyed coal licenses and leases in general is about the average. The area of land surveyed by the Government is practically double that of 1912, notwithstanding the fact that the expenditure of this year represents survey of land in all parts of the province, including the most difficult and dangerous sections.

SOME FEATURES OF HIGHWAY SURVEYING

A TREATISE DEALING WITH BOTH THE PRACTICAL AND THEORETICAL PHASES OF THE WORK—THIRD OF A SERIES OF ARTICLES ON THE SUBJECT.

By DANIEL J. HAUER
Consulting Engineer and Construction Economist.

IN a former article, highway engineering was described and commented upon up to the time of plotting the field notes.

Plotting Notes.—The plotting of the transit line and the surveyed area can be done on regular drawing paper, and afterwards a tracing made of it in ink to be sent to the chief engineer to have blue prints made from it. A better method than using ordinary drawing paper is to plot the alignment on profile paper. For this a sheet or roll of Plate A paper should be used, the upper half being used for the line and the lower half for the profile, or vice versa. Then, in the same horizontal scale, viz., 1 block, (or 2½ in.) = 100 ft., the line and profile run along in regular order and quick reference and comparison can be made of each. The vertical scale for the profile can be made 10 ft. to 2½ in. or one block. It is possible to shorten up this scale, but the plotting is not so easy and the paper thus saved will not equal the enhanced value of the drawing on the scale given.

Tracings of the plan and profile can be made on plain tracing linen, but better results can be obtained by using profile tracing linen, Plate A. From this tracing, blue prints can be made in the main office for office and field use. The importance of each party in the field plotting up the line and profile has already been stated, and if only this drawing work is done by the field party, a draughtsman is not needed. The making of all standard plans should be done in the office of the chief engineer.

The plotting of the alignment should be carried on each day, putting in on the plan all side measurements, the location of fences, property lines, where necessary, town and country lines, and showing the magnetic course of each. Culverts, bridges and waterways of all kinds should be shown, and the cross roads, private driveways, buildings and other features should be plotted. It may, at times, be necessary to locate telephone and telegraph poles, and the trolley poles for electric roads. It is sometimes necessary to move some of these poles, and so they should be properly located. Trolley tracks along a highway should always be located, and at times it is well to locate and plot on the map streams and other bodies of water that may be within several hundred feet of the highway.

Railway crossings of all kinds on the highway should be surveyed, and enough of the railroad line should be drawn to show how dangerous the crossing may be for rapidly moving vehicles. Changes of alignment of the highway should be made, if possible, to eliminate dangerous crossing. When money is available, and it is possible by legislative enactments to have the railroad share in the expense, grade crossings of the highway on the railroads should be eliminated, as under all conditions they are dangerous, but the elimination of such crossings is very expensive and few highway commissions have the necessary funds to do such work at present.

In plotting, each station on the sheet should be numbered in consecutive order. This is necessary as many men, such as foremen and supervisors, who are not accustomed to reading plans, will use the blue prints. The station numbers should be placed at the bottom of the plan, but all pluses should be noted in plain figures along the centre line.

At frequent intervals distances to the side of the road, to fence lines, and to buildings close to the highway should be shown. Care should be taken not to make the plan one mass of figures, but all important distances should be marked down. Too many plans lack essential measurements.

Buildings of different kinds should be shown by different symbols, and the various lines on the plan should likewise be shown by different kinds of drawn lines. A key of these symbols and lines given on one end of the plan allows each to be recognized without printing many words on the drawing.

The stations for the profile should be shown, but it is not necessary to reproduce the plus stations for these can be read from the plan. The elevations of the lines on the profile plate should be marked for every 10 ft. of elevation, and should be reproduced horizontally every 1,000 ft. The elevations should be marked at every change of the established grade together with the rate of the grade and whether plus or minus, on the grade line. The line of profile plotted should be the transit line. All culverts and bridges should be shown in a graphic manner, and with the elevations and plus stations marked on the profile.

The profile line is made with black ink, and the grade lines in red. It is sometimes a help in deciding on the many questions that arise, to plot the centre line and the two sides of the road. If these are only for office use and it is not considered necessary to have them show on the blue prints, these lines can be made in colors that will not readily blue print, as orange and yellow. If different colors cannot be used, and it is desired to have the lines show on the blue print, then various kinds of dotted lines can be used, a different line to show each profile.

The cross-sections taken can be plotted on the profile, or only special or typical sections need be plotted at convenient blank spaces. Outside of the typical sections, which should be on the profile, it is better to plot all the sections on regular cross-section paper, thus having a permanent record of the sections taken. In many cases these can afterwards be made useful, with replotting, in calculating the quantities of excavation and filling.

Whenever possible, there should be uniformity in all drawings and plans. For this reason, all standard plans showing cross-sections of road, and structures to be built, should be made in the office of the chief engineer and should be made the standard for all work to be done.

Trial Lines.—Trial lines or diversion of the road should be surveyed to make possible improvements in the alignment and gradient. As to the advisability of

such changes being made many considerations govern, besides the money available for such purposes. The money consideration is exceedingly important, for it is evident that if the amount of money is limited, but little of it can be expended for grading of new roads, if there are surfaces of old highways to be improved. However, if permanent improvements and betterments are to be made, to the end that good roads, admitting of economical hauling, are to be obtained, then it is manifestly wrong to improve stretches of roads that have poor and dangerous alignment and gradients that prevent fair loads being hauled.

Crooked highways with sharp curves are dangerous for automobiles, and more so for horse-drawn vehicles. A farmer with his wagon heavily loaded, meeting an automobile on a narrow road at a sharp turn, runs greater risk of being injured than does the party in the automobile. He, too, will be slower in getting out of the way. A steep hill means limitation of load. A team hauling a load 5 miles cannot carry any more than can be pulled up the steepest hill, even if it is a short one. This is an all-important fact to remember. Good roads not only mean good wearing surfaces, but also good grades, if we are to reduce the cost of hauling per ton-mile.

Thus, as a basis of any road improvement, sharp curves and heavy grades should be eliminated, so that money spent in the future for improving the surface will be upon a permanent highway. Money spent temporarily with a view of bettering the surface, only to change the line a few years afterwards is, to a great extent, money wasted; yet the amount of money appropriated for a certain highway may compel such makeshift work.

Even if a small amount of money, the importance of a close study of road changes is shown. Most country roads to be improved must be widened. This widening means extra grading, so that a decision as to relative costs of impróving the old line or adopting a new one must be reached only after a close study of alignment, profile and cross-sections.

This study must, to some extent, be made in the field, but only careful and close study of these features can be done from the plotting of these notes. This is another reason for the field party to plot up their notes. Then the work of running side lines or trail surveys can be done knowingly. For this work, the importance of both field and map study can hardly be overstated, even if a man has an exceptional "eye for country."

In making betterments, distances must be considered, but a larger load can be hauled a slightly greater distance at less cost than a smaller load over a steep hill. The distance travelled by a vehicle over a very steep hill is always more than the horizontal measurement. This may mean that a hill can be circled without a greater distance being travelled than in going over it.

In starting a trial line some point is selected on the transit line on the road and the new line deflected from it by turning an angle to the right, as frequently explained in making the survey. These lines are either numbered or lettered to distinguish them. A complete survey of the line is made, and all features of value in determining the cost of the work should be noted. Connection with the original transit line is made at some convenient point and again the full angle to the right is turned.

Levels are run over these trial lines and a profile made of each, and enough of the original line is plotted to show how the grade can be worked up.

Not only should crooked roads have trial lines run to better the line and grade, but every steep hill should have a line run around it. In the past too much money has been spent improving poorly located highways, instead of first bettering the location. Through well-populated improved country it is not always possible to better the alignment, but through unimproved country and open fields this feature of highway betterment should always be carefully considered. However, it should be remembered that long tangents are not necessary, for sweeping curves are not a detriment, but rather add to the beauty of a highway. Heavy gradients should always be avoided.

Traffic Records.—The cost of all highway improvements must be gauged, not only by the money available, but by the traffic that goes over the highway. Many laymen, who are road enthusiasts, advocate the building of first-class roads in all sections. These are much to be desired, but it is an unwise policy to expend large sums of money on by-roads, when we have so many heavy traffic roads to rebuild. The following of this practice is seen in the laws enacted for road betterment. In some sections, in order to obtain money from the provincial or state government to improve local roads, these highways must be made a certain width, cannot have greater than a specified grade, and must conform in other ways to a high standard. Through this kind of folly, the writer has seen roads that had less than a dozen vehicles pass over it in a day, made 24 ft. or more in width, when the old road was not more than 10 ft. wide. On the other hand, he has seen roads, built under the same laws, with excessive travel on them, to the point of being dangerous, built the same width.

Traffic records are essential to make knowing decisions as to highway improvements. Such records should show the number of vehicles moving over the road during the daylight period, these observations varying to suit the conditions as found. It is not enough to make such studies only as surveys are being made. Records should be kept for a longer period, and should show both summer and winter traffic. Sunday records should be kept, as many pleasure vehicles are out on that day when the weather is fair. The records should show the size and kind of vehicle, the load carried, the average length of trip and the extreme length of some trips, thus showing local and through travel.

With complete records of this character it is possible to decide upon the width of road needed, the kind of road surface to be built, and the need of bettering the line and grades. Many roads can be made from 14 to 18 ft. wide with a hard surface in the middle 10 ft. in width, and answer every need of the traffic. It is a manifest waste of money to go beyond this in a large number of cases.

Geology.—Geological conditions, as well as those called for by the traffic, must be considered in these matters. The cost of work will vary with the geology of the country. In making the survey, all geological features should be observed and recorded. The character of the soil, the location of rock and its character, should be noted for every station. The quarries, sand and gravel pits, and clay banks along the highway should all be located and shown on the plan. This should be done also on the trial lines. Frequently a road is expensive to maintain, due to the character of the soil, when a parallel line within a short distance can be kept up at half the cost. Likewise, it is expensive to cut down hills, with large boulders out-cropping, or ledge rock, in order to improve grades. To widen many roads

in their present location, means to get into rock and rough ground, that the original locaters avoided with a narrow road.

Adopting New Lines.—With surveys completed, trial lines run, traffic and geological records made, and the amount of available money known, the engineer and highway official are ready to decide upon the line to be improved. To obtain all of this information may have cost some money, but it is an expenditure well justified and one that will save a much greater sum in the end. This, though, is at variance with the practice of many engineers and highway officials, who first decide upon the line to be improved and then have surveys to find out what work is to be done. Such surveys are needed, but the other records and considerations do not enter into the problem; yet they too are obtained, and boasted of by those in authority, although it is money wasted, as far as any good obtained from them is concerned. This practice is only to be condemned.

It is not possible to give any rules for deciding upon alignment and grades. The information obtained from the surveys and records mentioned must govern the selection, based upon sound judgment gained from experience. The engineer should be the one to make the final decision, but even a layman, with such information before him, can assist in deciding upon the proper line.

Laying Down Grades.—Although the alignment of a road decidedly affects the cost of highway construction, yet the establishing of grades is a more potent factor. A few tenths in elevation does not greatly affect vehicle traffic, yet if they mean the blasting out of rock by hand methods, an excessive cost is entailed.

The limit of gradients should be set by the vehicle traffic records. Generally 5% should be the maximum grade, as with such fair loads can be carried and rapid-moving vehicles have no trouble in climbing. But, if the traffic is light and such grades mean excessive cutting, then gradients up to 8% may be used.

The establishing of new grades alone may mean the changing of a line. Thus it may be cheaper to build a new road on easy grades than to cut down hills to the maximum grades.

Care must also be taken not to make grades too decided and long, as is done in railroad construction. Many engineers, experienced in railroad work, entering the highway field, make this mistake. There is no need in highways of long straight lines with grades causing deep cuts and high fills. These cuts mar the beauty of the country, obstruct the traveller's view, and mean a great cost in building and maintaining the road. High fills are dangerous, must have guards on each side to prevent accident, and are washed badly by summer showers or in flood periods. As with the alignment, the grades can be sweeping curves, so as to keep down the cost of construction, yet keeping in view the traffic to be carried. It is even possible to have short raising grades to go over various obstacles, as small knolls, bridges and railroads, care being exercised in not making them too steep and short and with the proper view for approaching vehicles. This prevents long, high embankments.

In establishing grades care must likewise be exercised in preventing the top of a grade from being so sharp that vehicles cannot see one another in approaching. All changes of grade should be made with vertical curves. The value of proper drainage can hardly be overestimated, but drainage to some extent is dependent upon the laying down of proper grades.

Deciding Upon Improvements.—The next question to be considered is that of how improvements are to be made, the width of road, the surface to be laid and the method of doing the work.

One prevailing idea is to do as many miles of work as possible with a given sum of money, expending some in each town or road district, that is, not to build a good road of some particular type, but rather to repair the roads as they may be at present. This means to do little work that is permanent, giving only passable roads for a season and possibly taking out a few bad curves and grades. It is a wasteful procedure and defeats the object of any legislative act to improve roads. Nevertheless, it is a popular method, as it means the expending of some money in each community, the so-called "pork barrel" distribution of public funds. The roads on the North American continent need rebuilding and not just repairing as a bit of political jobbery to curry favor with the unthinking classes.

The second method is to decide upon the kind of road to be built in a given section, the width, alignment, grade and surface to suit the traffic and local conditions, taking into consideration the money available. Then build the very best road possible under these governing factors. Thus, wherever work is done good highways are obtained, and if properly maintained, a permanent improvement is made, the taxpayers receive full value for their money, and with the benefits that accrue to the community from the use of such roads, there is a demand for a greater mileage and the public gladly acquiesces in making financial arrangements for additional work. This scheme should be advocated by all those desiring to have good roads.

Even with this method, short sections of roads are built in different districts. This is a political aspect of the subject and, unfortunately, it is necessary to follow out this system to some extent, as otherwise many communities, feeling they are being slighted and deriving no direct benefit from the expenditure of the road money, will vote against future bond issues, although by so doing they are cutting themselves off from enjoying the benefits of future improvements.

As far as possible, long stretches of roads should be improved at a time. Economic reasons make this imperative. Small contracts mean high prices. The cost of plant for road construction is high, much higher than for many other classes of work, and so the plant charge against a small job is much higher than for a larger undertaking. As the road building season is short, especially in the north, a job should be large enough to keep the forces and plant busy for a season, without being moved. All of these and many other considerations will mean more road built for the same money.

Contract Work.—There are two methods of having the construction done on roads. One is by day labor forces, that is by men, machines and teams employed by the day, working under the directions of the road engineer and his assistants. The other is to let the work by contract, the contractor doing the work under the supervision of the engineer.

The first is generally an extravagant method; men do not work their best under such conditions, nor is the character of the work done of the best. Under the contract system the contractor is responsible; he requires men to work well, he is made to live up to the specifications and contract, and the unit cost of the work is known as soon as the contract is let.

The contract system can also be used for highway maintenance. Specifications can be drawn up for such work and it can be paid for by various units, according to the character of the work. Space will not permit of a further discussion of this subject, but the better method is to build and maintain highways by contract.

Road Surfaces.—A decade or two ago there were only a few kinds of road surfaces in use, while to-day they are numerous. Many of the patented surfaces and some of the newer types have not been in use long enough to definitely learn their advantages and disadvantages, but every road engineer should make a close study of all the different types. In some cases chemists must be consulted.

In deciding upon the surface to be used, the governing factors must be the amount and character of the traffic and the materials that can be obtained for the money available. This may necessitate the use of local materials, and the engineer should know enough about the various kinds of surfaces to select the best. Too frequently poor results are obtained from a lack of knowledge of this part of highway engineering. Only recently the writer saw a young engineer stop the use of beach gravel on a road, because of a lack of binding qualities of the gravel, and compel the use of a rotten rock from a pasture, which was ground up into mud within 6 months. Had he had some of this rock mixed with the beach gravel, and a small per cent. of suitable clay, he would have had a fairly good wearing surface, and the money would not have been wasted. This, too, would have cut down the cost of maintenance for some years to come. In deciding upon all surfaces, the ease and cost of maintenance should be considered as well as the adaptability of that particular kind of surface. Then, too, the cost of some materials may seem prohibitive, but this may be offset by the low cost of maintenance.

Locating the Road.—After all of the foregoing matters are decided the proper location of the new centre line is made. This location should be laid out on the ground. To do so, a new transit line is run, in the manner previously described in making the survey. Where the line has not been changed the same transit points and reference hubs can be used. This new line should be well referenced, and the stakes marked "L" showing that it is the located line. Then, new levels should be run over this transit line. The side levels are not necessary. From these levels a new profile is made, and then the work can be cross-sectioned.

All cross-sections should be calculated and payment for the work made on them alone. A standard section of the road should be made, and this should be followed in carying on the work.

Drainage.—Too much attention cannot be paid to the drainage of highways. Water is a sure detriment to all road materials. Roads should have ample subdrainage as well as surface drainage. Ample drainage should also be provided to prevent water from going onto road surface. It is easier to do this than to drain off the water after it has gone upon the highway.

Ample waterways, made of the most permanent materials, should be provided under the highways. To-day, in both Canada and the United States, millions of dollars are being wasted in maintaining flimsy, out-of-date culverts and bridges on highways. It is evident that if these could all be replaced with permanent structures, the money that is being spent each year for maintenance could be expended on the road surfaces.

RAILWAY TUNNELLING.

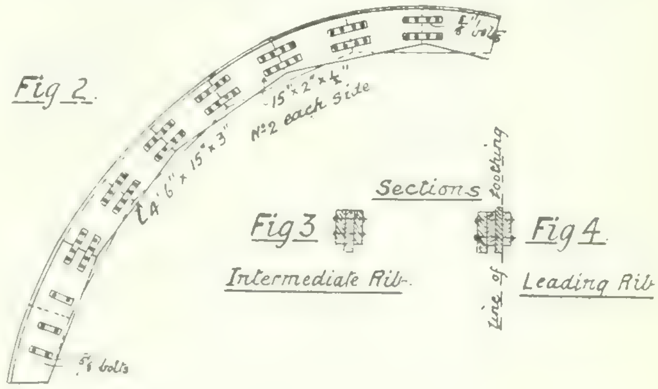
(PART II.)*

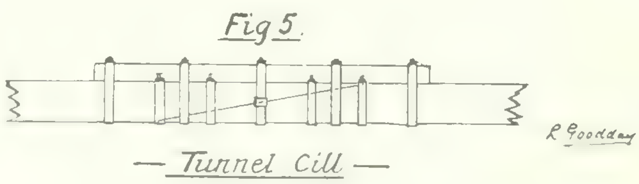
By Leonard Goodday, C.E., M.E.,
Late of the British Admiralty.

THE cost of driving a heading of the size outlined in Part I. of this article (January 15th issue) can be estimated only approximately, as it varies with the nature of the ground. In good shale, and where water does not prove a serious obstacle, conditions are most favorable to economical construction.

To arrive at an approximation of the cost per yard one must include excavation, timbering and supplies, operating expenses, percentage for engineering and contingencies, etc.

If the head-tree be 10 in. and side trees 8 in. in diam., with poling all around the excavation, per yard forward will be 10 ft. 7 in. x 8 ft. 6 in. x 3 ft. = 10 cu. ft. This may be let piecework, lineal, to include timber setting, but not to include pumping, power for hoist, or foremen and timekeepers.





A head-tree, 10 ft. x 10 in. diam.; 2 side-trees, 8 ft. x 8 in. diam.; 2 hard-wood foot blocks; and about 110 ft. B.M. of poling boards, constitutes the required timber per lineal yard of tunnel. Poling boards of 1½ in. thickness might at first appear unnecessary. It should be remembered, however, that some of them will probably remain in place until the tunnel is almost completed, subjected to dampness and rot, which soon impair their strength.

From the shafts sunk at either end of the tunnel, a heading may be driven back through the cuttings leading up to the tunnel's mouth until it reaches the face at which the cutting excavators are working. "Shoot-holes" can then be driven upwards from the roof of the heading to the surface of the ground; strong trapdoors are then fixed in the bottom of each hole at the level of the heading roof and opening downwards. Tip-wagons can be run under the holes, the doors opened, and the earth shovelled down from the top. In good ground, indeed, in almost any ground, 2 men at the hole will do as much as 4 filling in the ordinary way.

*Part I. appeared in Jan. 15th, 1914, issue.

This method does not work so well in a wet, or rock cutting, as the water naturally drains into the wagon, and by the time the latter has got to the tip-head, its contents are slurry; another drawback is that rock falling down the holes breaks the doors and wagons.

If the slope of the ground is about 1 to 1, the distance between these shoot-holes will be twice the depth of the cutting at these points. With 5 shafts, there will be 2 working faces at the cutting headings, or 10 in all. If the work is to proceed rapidly, 20 gangs will be required, including day and night shifts; so that for a gang of 2 miners and 4 laborers, 40 miners and 80 laborers will be the total strength. A boy for every 2 gangs, for fetching tools, etc.; a hanger-on at the bottom of each shaft to attend to skips and ring the signal-bell; and on the bank at least 2 banksmen for landing and tipping the skips would make up the staff.

As the heading progresses, light rails of about 15 or 20 lbs. per yd. are laid with a gauge of 2 ft. 6 in., on which small trollies operate, similar to those required on the bank. On these are carried the skips, each of which has a capacity of about 1/3 cu. yds. If it is intended to get tip-wagons into the heading when it is driven through, it may be as well to at once lay the temporary wagon road, and on it to place larger trollies, similar to those used by sectionmen. These will carry 3 or 4 skips each trip. To draw these a pony will be required, which can easily be stabled in a recess made in the heading.

The shafts in the tunnel under consideration are about 440 yds. apart, giving 220 yds. of heading to be driven from each face. At 1 yd. per shift for progress, this gives nearly 4 months as the time required to join the headings. Before this is finished, the mining and lining can be commenced from the shafts, the engineer having satisfied himself that the lines are correct, but it is wiser to commence a "break-up" when the heading is through, at least between any 2 shafts. A break is generally made midway between 2 shafts, and, consequently, at or about the point where the headings from the shafts meet.

When the headings are through, the engineer must give working centres again. He will be able to judge pretty well how correct his first lines were by the way the headings have met. Let one wire down each shaft and with the transit work the centre line in from the cutting outside. Run a trial line through the tunnel, leaving points as this work proceeds, and checking on the wire at each shaft. This trial line requires going over 2 or 3 times, as it is seldom correct the first time. When correct, it is necessary to fill up with permanent points between those left on the trial line, and to take notes of the position of each point, so as to be able to recognize them. Mischievous and discharged men, etc., have been known to move these points for spite or through ignorance. Establish plainly marked Level B.M.'s all along the heading at Rail Level.

When driving these headings water may be tapped, which must be conducted to the sumps under the shafts, so that it may be drawn off at certain intervals. A large barrel, holding 40 or 50 gals. and called a "landing barrel," is required for drawing this water up the shaft. Unless water enters in large quantities, this will serve all through the work. Otherwise a steam pump will best get rid of it. The former outfit must be complete in every way, with the trunnions on which it turns below its centre of gravity, so that when the catch is released it will tip easily and without disconnecting it from the winding-rope. Over 2,000 gals. per hr. can be raised by this means.

The contractors should see to the provision of a large supply of strong larch forbars for supporting the mined length, poling boards, brick, etc.

With respect to brickwork, if brick is used, an ordinary tunnel for a double line, without an invert, with walls and arch 2¼ ft. thick, and of the dimensions shown on the figure, will contain 17¼ cu. yds. of brickwork per yd. of length. If each length turned is 5 yds. long, this amounts to 86¼ cu. yds. If 350 bricks, 9 x 4½ x 3, are reckoned per cu. yd., a length will then require 30,000 bricks, and with 5 shafts, in 2 of which one length each per 10 days is to be turned (work only progressing in one direction from them), and 3 shafts, 2 lengths each per 10 days, one in each direction, are to be turned, there will have to be provided sufficient for 8 lengths in the course of each 10 days, or 240,000 bricks—a quantity hardly obtainable in most localities. Even if available, there might not be adequate means of transportation. Supposing the locality to be surrounded with brick works and the average distance to be 1 mile, a horse would make 5 journeys per day and bring 300 bricks per journey, or 1,500 per day. As 240,000 are wanted in order to keep up the supply, 16 horses and carts and 2 extra horses and carts for continual work would thus be needed. Besides these 18 horses there are all the others required for general work. An alternative worthy of first consideration, if the facilities for the operation are available, is the manufacture of brick at the site.

The section of the tunnel and thickness of lining having been decided upon, 26 ft. clear between the walls is the minimum for a double line. This width will depend upon the type of car and locomotive which the cross-section was designed to allow. It must be remembered that when a tunnel is on the curve, the cant of the outer rails causes the corners of the car to project. Therefore, keeping the same total width, the wall on the inside of the curve should be a few inches farther from the centre line than that on the outside. The centre line is still the centre line, between the rails, but is not that of the tunnel. This little difference can easily be adjusted when the curve enters the straight again.

We have supposed 5 shafts, 3 of which have 2 faces, one working each way, the other two shafts having one face each. Between each two shafts, a breakup is to be formed, which gives another 2 faces to each breakup. There will be 4 breakups in this case, and, consequently, 8 faces. Thus there are 8 faces due to 5 shafts, and 8 more due to the breakups, or 16 in all. In an organized tunnel, a length will be mined in 8 of these faces, and the bricklayers will at the same time be lining the 8 others.

For supporting the arch of a 5 yd. length, at least 3 ribs are required, 2 of them called intermediate, the other, "leading." A the ribs should always be left standing in 1 length until the next at the same face is keyed, it follows that 4 intermediates and 2 leadings are required per face, giving 96 ribs in all. These must be ready, with a few to spare for breakages, when the brickwork is commenced. Fig. 6 shows the curve of the arch beginning at about 6 ft. above rails, it being the real springing point of the arch. A scaffold is needed for this work, and it is advisable also to lay the finishing courses of the walls from this scaffold. Generally, centres are set at about 9 ft. above rails, and which point is called the springing.

The ribs should be built on a good, level platform, on which the soffit line, full size, is accurately described, with 2½ in. allowed below it for lagging. The tunnel being a heavy one, the ribs must be of well-seasoned ash or elm, and built up of pieces called sweeps; each one being

4½ ft. long, 1¼ ft. deep and 3 in. thick; for an intermediate rib 3 thicknesses of sweep, or 9 in., will be sufficient. One edge of each must be neatly adzed to the soffit line; keeping the full depth of the sweep at the middle. Fasten all together at every joint with 4 iron plates about 15 in. x 2 in. x ½ in., bolted completely through with No. 4 ⅝ in. bolts, having all bolt heads on the same side, as by keeping the heads all on one side, the rib can be more easily dragged about on the tunnel scaffold.

A leading rib is constructed in the same way, but with 4 thicknesses or layers of sweeps, one of the 2 inside layers projecting 2½ in. above the others, or equal to the thickness of a lagging. This rib is set at the leading end of the brickwork to be built, and remains in place. When the arch of the next length is ready for turning, the laggings find a bearing point on this rib on the other side of the rim. It also keeps them from slipping. Figs. 2, 3 and 4 show an elevation and sections of a rib.

support but that of the centres. The pressure must be very slight to allow such a condition.

When the ground is heavy and pressure great, the arch and length cannot be left without support, and the contractor cannot afford to leave bars bricked in above the brickwork in every length. Drawing-bars are introduced, bars so placed that the arch can be keyed in under before they are drawn out endways into the next length to be mined and used again.

The crown, i.e., the top bar, and 2 others on each side of it, 5 in all, form a set of drawing-bars. Those on each side the crown bar are called "third bars," because when in place, there are 3 bars in; the next 2 are called fifth bars, next 2 seventh, etc. The crown, third and fifth are all of a size, and, in a 5 yd. length, must be 21 ft. long at least. In heavy ground they should be not less than 16 in. diam. at the small end. They must be straight, free from knots, and should taper uniformly.

All the bars carrying the roof are supported upon a top sill, placed about 9½ ft. from the underside of the

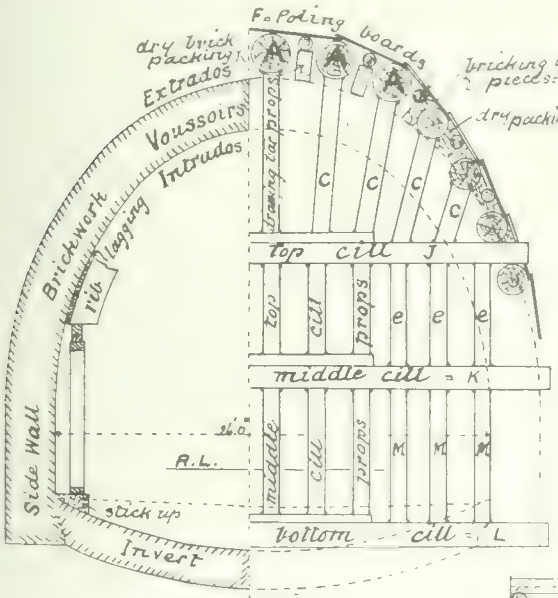


Fig 6.

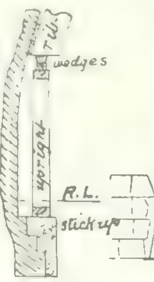
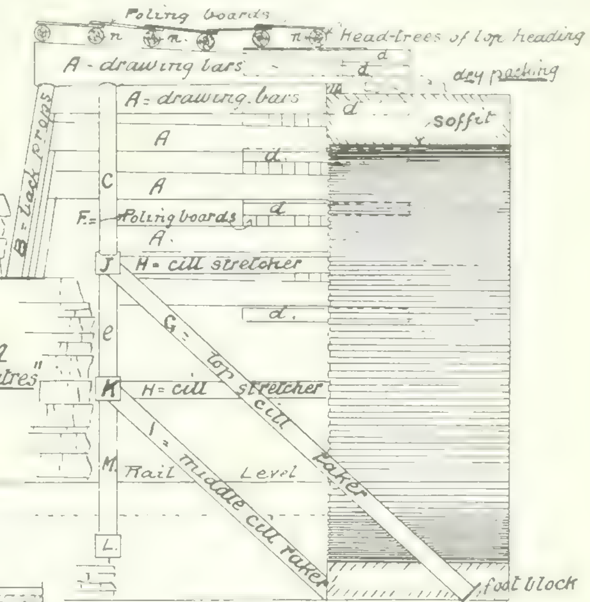


Fig 8
Timber framing Supporting "Centres"


— Plan of Fig 8 —



— Fig 7 —

Mining and Timbering.—The excavating and building-in of a tunnel is done in lengths, one length being mined and lined completely before much work is done in the next.

The extent of a length is determined by the probable weight which must be supported on the bars until the brickwork can be placed; also upon the size and quality of the timber procurable for bars. A length is seldom more than 6 yds., and is sometimes reduced to 3 yds. In a light tunnel all bars carrying the roof can be taken out as the brickwork is built up to them. The ground is excavated and mined as nearly as can be to the exact shape of the extrados of the lining. Therefore, the back of the bars supporting the ground is just even with the back of the lining, excepting 5 or 6 of them at or near the crown of the arch, which are kept up a few inches to compensate for settlement and sag. When the walls are built and the arch is under construction the bars are removed one by one as the work proceeds until the arch is keyed. It will be obvious that when the arch is within about 4 ft., measuring transversely, of completion, the crown, or top bar, must be taken out, and that the ground and incomplete arch are thus left without any

crown bar, and stretching horizontally across the tunnel at that level, just at the leading end of the brick work to be built. This top sill should be 13 in. square and 27 ft. long. (See Fig. 5.) The roof bars are all propped from it, and it is again supported, by props from another or middle sill, which should be yet stronger and 33 ft. long. The top sill cannot be put in place until the ground is excavated down to its position, and the ground cannot be mined without support from bars. The bars, in their turn, must be temporarily supported until the top sill is in place, so they must be long enough to allow of their being propped off firm ground, ahead of the length under construction. The roof bars should be 21 ft. in length.

The best timber for bars is larch. They should not be stripped of the bark as the timber then becomes slippery in damp places, and difficult to handle. They should be neatly scarfed for 5 ft. to make a sill. The top and bottom of the scarf should be faced with an iron plate about 6 in. x 4 in. x 1¼ in., and the 2 plates bolted together through the sill and enclosed by 4 iron glands. On the top of the scarf is placed a timber saddle the full width of the baulk, 6 in. x 9½ in., the whole

being secured by 5 additional glands, made out of 2½ in. x ½ in. flat bar.

The section of timber to be encircled by these glands is 13 in. x 13 in. for the sill proper, and a 13 in. x 6 in. saddle, making 13 in. wide x 19 in. high. The gland is made in 2 parts, one formed into 3 sides, to take the bottom and the 2 sides of the sill and saddle. On the ends of the 2 sides which are made to project beyond the 19 in. required, are formed good screws with nuts. The top side of the gland is then made separately, and long enough to provide for a hole in each end to fit over the screwed ends of the other piece, and the nuts screwed tightly down. The sill must be scarfed as it has to be longer than the width of the tunnel. As a sill should serve all through the work and will be taken to pieces many times, it should be well made. (See Fig. 5).

The first side length, next the shaft, let us suppose to be in and lined; this operation being similar to the following, except that sills must be used at both ends of it. But if bad ground has been encountered in sinking the shaft it will be safer to brick the crown, and third bars in the first side length, and not attempt to draw them, for fear of settlement. The fifth bars in this case must be "taking out" bars. The shaft length should not be taken out and lined until the shaft work is finished.

It has been decided to line the tunnel with 2½ ft. of brickwork. The lengths, to be got out one by one, shall be 5 yds. To support this length, 5 drawing bars shall be used, each 2 ft. diam. at the thick end. The drop shall be 1½ ft., i.e., the small end being borne upon the end of the brickwork of the last length, and the other end being set at a higher level by 1½ ft. to allow for sagging, settlement and possible breakage.

The first operation for the second side length is to drive a top heading 21 or 22 ft. long (enough to receive the crown bar) and high enough for a man to stand in it. It should be wide enough to take the thick end of the bar, say, 3 ft. in the clear under the head-tree. The distance apart of the bars is generally about 1½ ft., so that to take 2 bars, 2 ft. in diam. and 1½ ft. apart, the heading must be 6 ft. wide under the head-tree, and between side-trees. In very heavy ground 2 crown bars are sometimes used, as they together give a greater bearing for the head-trees, and support it better when the side bars are put in, or taken out. The heading must be supported by settings of head and side-trees about 1 yd. apart, and strong enough to bear the weight for 10 days or so. The heading should be poled all round.

The crown bar must be got into this heading by means of a crab and tackle.

As the top sill (Fig. 7) will be placed at about 6 ft. below the soffit of the arch, the ground at the far end of the top heading should be excavated across the heading down to a little below this level. In the bottom of this, foot blocks should be placed, on which will stand the long back props, supporting the bars until the top sill is in position. These back props should be 10 to 12 in. diam. and up to 9½ ft. long. Their length varies, of course. All props should be "collared," i.e., on two opposite sides at the top end cut off about 1 in. and run out about 9 in. down the prop; and then hollow out the top of the prop to receive the round side of the bar, which will give a good bearing surface, and prevent the outside from splitting. The props should be set with a sprag.

The crown bar being in and back propped, the next necessity is to get in the third bars, but as they must follow the curve of the arch, they are not quite so high above rail level as the crown bar. Widening out for these bars can be commenced by removing the side-trees of the heading, and the poling boards, and then excavating from the sides. When the third bars are in, short stretchers must be put in between the bars spaced about 5 ft., strutting one bar against the other, so as to distribute the pressure. Dog-headed spikes, or brobs, must be driven into the bar round the head of all props, four to a prop, to prevent slipping. When this excavation is done, poling boards must be placed transversely to the bar. The proper way, when the face of the excavation is straight, is to insert the board above the last bar put in, and hammer it into place; but as the excavation here is curved, it is sufficient if the ground be removed from behind the bar on the underside, and the board hammered upwards, until held by the bar.

The fifth of the set of drawing bars is now put into position. They hold the lower ends of the poling boards, and must be back-propped similarly to the others.

With an occasional helping hand, 2 miners and 3 laborers will get the crown and third bars into place when driving the top heading. As space widens out, and the fifth bars are got in, another miner and 2 laborers can be added. When the seventh bars are in there will be room for the whole gang, consisting of a gang boss, who must work as a miner, 3 miners, and nine laborers.

The fifth bars being in, spaced with 1½ ft. drop at their leading end, in placing the seventh bars. The extra size of mined section due to this drop allowance must be begun to be worked out, and the bars below the fifth brought gradually nearer in to the line of the extrados of the brickwork, until at a few feet below the level of the top sill, the line of the back of the brickwork is regained. The set of drawing bars occupy about 15 ft. of the circumference of the mined section, and in a 5-yd. length there are consequently 15 ft. x 15 ft. x 1 in. = 225 cu. ft., or about 8½ cu. yds. excess of mining over and above the net section of the brickwork owing to the allowance necessary for drop, before this is worked out, and the net dimensions of the bricked section regained.

No drawing bars would be required with a light tunnel, and this excess would be prevented. The seventh bars can be smaller than the drawing bars in length and diameter, as they are not under strain so long. They must, of course, be longer than the actual length to be lined, as they require back propping until the sill is in.

When the length is mined down to the top sill, which must then be got in. The front or side of it facing the length must be a little more than 15 ft. from the last toothing which extends horizontally across the length, and 2 ft. into the ground on each side behind the proposed brickwork. Working this 2 ft. is called driving the sill hole. It is an expensive piece of work in hard ground, and dynamite will be found expedient in doing it. Bring the sill into the tunnel in halves with saddle and glands loose, the ground or sill bed being levelled and the sill holes driven. Place one half in its position and level it well before slipping on half of the glands, with screwed ends pointing upwards. Set up the remaining glands in about the position they should occupy on the other half sill, and drop this half into place, fixing it over the scarf with the plates. If from wear, etc., the glands do not all fit tightly, tighten them up with wedges. Prop all the bars of this sill, taking care to collar the props and drive brobs in at both top and bottom. The back props, which have up till now been supporting the bars, may be taken out.

(To be continued.)

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CONTENTS OF THIS ISSUE.

SEWAGE TREATMENT IN SASKATCHEWAN.

The Bureau of Public Health of the Province of Saskatchewan will shortly issue a number of official suggestions respecting the design of sewage treatment works for municipalities of that province. In issuing the bulletin the Commissioner of Public Health places before the people of Saskatchewan an interim outline of the more important considerations in the design of plants for the treatment of sewage. It will be found of vital and immediate importance in the conservation of the purity of water, and will doubtless be followed by others, in an aim to supply the municipal engineers of the province with a knowledge of the records and data which experimental plants on this continent and in Europe are contributing.

These suggestions, appearing on another page of this issue, are being submitted without intention of limiting in any way tendencies toward originality of design or of discouraging the incorporation of new features. To avoid mis-interpretation in this respect Dr. Seymour is making it plain that, under certain conditions, sewage treatment works designed at variance with the suggestions which are being presented, may be approved of by him, and conversely, that sewage treatment works designed strictly in accordance with these suggestions may not be approved of. It may be necessary to make such modifications as the requirements of local conditions justify.

EFFECT OF TAR ON ROAD SURFACES UPON FISH AND PLANT LIFE.

From a late reference to the subject in the London Financial News one would infer that the conclusion appears to have been arrived at on the European Continent that the use of coal tar from gasworks for the treatment of road surfaces has a number of drawbacks, not the least of which is that all vegetation in the vicinity of roads which have been tar-sprayed suffers heavily. Another of almost equal importance is that it appears to be impossible for fish to live in those streams which receive, either directly or indirectly, the drainage from their surfaces.

Engineers in America and Great Britain do not agree with the contention, and a number of facts have been tabulated which appear to show that the conclusions have been altogether of too sweeping a character. The "Journal of Austrian Gas and Water Engineers" recently published some information on the subject, and it is interesting to note that M. Griffon, a Parisian engineer, has made careful investigations as to the effect of coal tar on neighboring vegetation, and finds that it has little or no effect, thus upsetting the conclusions of Herr H. F. Fischer in this regard. As an example of this it may be mentioned that in Bordeaux one of the principal streets has been tar-sprayed for a number of years without a single tree suffering. As the point might be raised that the trees in the vicinity might have been of a specially hardy species, he is careful to mention that among them were such varieties as maples, silver poplars, lindens, and walnuts, all of which are known as being of a particularly sensitive character. At Montpellier all the macadam roads have been sprayed with gasworks tar for several years, and the plane trees in the vicinity are in much better condition than was the case before the treatment was adopted, owing to the absence of dust under the improved conditions. At Alexandria, in Egypt, the engineer responsible has found that the treatment of the roads by crude tar has had no effect on the vegetation in the neighborhod, and he gives details of many informative

tests which he had carried out before finally committing himself to that opinion.

As regards the effect on fish life, however, all the evidence obtainable appears to show that there is much in the contention, and it would appear to be advisable to construct all roads of one or other of the tar-macadam systems at present available than to adopt a spraying method, which, after all, can only be considered as a palliative, and so ensure a lasting road surface which will withstand the exigencies of modern vehicular traffic.

CONSULTING ENGINEERS AND CONTRACTORS.

At the annual meeting of the American Institute of Consulting Engineers, Inc., held January 20th, 1914, the following report was made and adopted by the meeting:—

"The committees on Professional Practice and Ethics and Relations held a joint meeting at the Railroad Club on January 2nd, 1914, to discuss the resolution adopted by the executive committee of the General Contractors' Association on August 6th, 1913, which resolution was referred to our two committees at a meeting of the Institute on October 31st, 1913. Your committees have the honor to report to the Institute as follows:

First: In respect to charging a fee for the use of plans, it is our opinion that, when contractors are invited to bid upon any work, the necessary plans should be furnished to them by the engineer without charge. If, however, the work is to be publicly let, there should be some limitations made with regard to the number of plans to be furnished free by the engineer. We believe that in such case the public or advertised invitation for bids should provide that the plans be on view at one or more places where all bidders can conveniently call and examine them. If prospective bidders ask for the use of plans under this last condition, we believe that the engineer should require a deposit for them, which deposit may be in an amount sufficient to insure the return of the plans, and that when such plans are returned to the engineer, after the award is made, the engineer should return the amount of the deposit.

Second: We are of the opinion that a sufficient number of plans for the execution of a contract should be furnished the contractor without charge. As to the number of sets of such plans, we are unable to make any definite recommendation other than that we believe the engineer should furnish sufficient for all reasonable construction purposes, and for any number in excess thereof he should charge the cost of reproduction.

Third: We believe that the engineer employed by a private client should lend his influence against the requirement of a deposit of a certified check by a contractor bidding upon his work.

Fourth: We are of the further opinion that it would be advisable in the interest of all concerned that the subject matter of the General Contractors' resolution be discussed by a joint committee composed of equal representation from:

(a) American Institute of Consulting Engineers, Inc.
(b) American Institute of Architects.
(c) General Contractors' Association.

We therefore recommend that the secretary of the American Institute of Consulting Engineers, Inc., be directed to invite the other two associations in interest to join them in the appointment of a committee which may take up this subject to the mutual benefit and interest of all."

CANADIAN CEMENT PRODUCTION AND CONSUMPTION IN 1913.

The Department of Mines, Canada, has issued a preliminary report compiled by J. McLeish, B.A., chief of the Division of Mineral Resources and Statistics, in which it is officially stated that the financial stringency during 1913 had an immediate effect in the restriction of building operations of all kinds and its results are shown in the statistics of production and consumption of structural materials. In the case of cement, while a very substantial increase in production is shown, this has seemed chiefly to displace imported material, the increase in consumption being only 4 per cent. as against an increased production of 24 per cent. Canadian mills supplied over 97 per cent. of the consumption in 1913 as against 83 per cent. in 1912. The industry has been marked by the extension of old and the completion of new plants, the latter west of the great lakes. The total capacity of completed plants at the end of the year being about 50,000 barrels per day as compared with 36,500 barrels at the end of 1912. New plants were placed in operation at Winnipeg, Marlboro west of Edmonton, Princeton, B.C., and at Tod Inlet, Vancouver Island, B.C. The plants of the Imperial Portland Cement Company at Owen Sound and of the Crown Portland Cement Company were not operated during the year.

The total quantity of Portland cement, including slag cement and natural Portland made in 1913 was 8,880,983 barrels, an increase of 1,739,979 barrels or 24 per cent. over 1912. The quantity of Canadian cement sold or used was 8,658,922 barrels, valued at $11,227,284, or $1.29⅔ per barrel, an increase of 1,526,190 barrels or 22 per cent. and $2,120,728 or 23 per cent. in total value. The total imports of cement were 889,324 cwt., equivalent to 254,092 barrels of 350 pounds each and valued at $409,303, or an average of $1.61 per barrel, as compared with imports of 1,434,413 barrels valued at $1,969,529, or an average of $1.37, in 1912. The total consumption of Portland cement, therefore, neglecting a small export, was 8,913,014 barrels as compared with a consumption of 8,567,145 barrels in 1912, an increase of 345,869 barrels or only 4 per cent.

Detailed statistics of production during each of the past three years are shown in Table I.

Table I.

	Barrels. 1911.	Barrels. 1912.	Barrels. 1913.
Portland cement sold	5,692,915	7,132,732	8,658,922
Portland cement manufactured	5,677,539	7,141,004	8,880,983
Stock on hand Jan. 1	918,965	894,822	866,138
Stock on hand Dec. 31	903,589	903,094	1,088,199
Value of cement sold	$7,644,537	$9,106,556	$11,227,284
Wages paid	2,103,838	2,623,902	....
Men employed	3,010	3,461	....

The average price per barrel at the works in 1913 was $1.29⅔ as compared with $1.28 in 1912 and $1.34 in 1911 and 1910.

The imports of cement in 1913 included 77,356 barrels from Great Britain, 172,298 barrels from the United States, 3,443 barrels from Hong Kong and 995 barrels from other countries. The average price per barrel was $1.61 as against an average of $1.37 on imports in 1912.

Annual Consumption of Portland Cement.—The consumption of Portland cement during each of the past five years was as shown in Table II.

TABLE II.

	—Canadian—		—Imported—		Total.
Year.	Barrels.	%	Barrels.	%	Barrels.
1909	4,067,709	97	142,194	3	4,209,903
1910	4,753,975	93	349,310	7	5,103,285
1911	5,692,915	90	661,916	10	6,354,831
1912	7,132,732	83.3	1,434,413	16.7	8,567,145
1913	8,658,922	97.1	254,092	2.9	8,913,014

SEWAGE TREATMENT WORKS IN SASKATCHEWAN.

THE following suggestions with reference to the design of sewage treatment works are formulated upon principles of sewage treatment which are in accordance with present day practice, and are about to be issued by the Bureau of Public Health of the Province of Saskatchewan to serve as a guide to those preparing schemes for municipalities in the province.

Screening.—(*a*) That where sewage is to be pumped, provision be made for screening, cleaning the screens at regular intervals, and for removing and disposing of screenings.

(*b*) That where works are of a character producing a large quantity of screenings, mechanical means must be provided for their removal.

Grit Chambers.—(*a*) The function of grit chambers (or detritus tanks) being to arrest the heavier mineral particles carried in suspension, the construction of such tanks is, generally speaking, unnecessary in this province, where the majority of sewerage systems are designed on the "separate" principle.

(*b*) That in special cases where sand or other mineral particles cannot be kept out of the sewerage system, it is advisable to introduce grit chambers.

(*c*) That these be constructed in multiple compartments to take care of the varying volume of flow.

(*d*) That a lineal velocity of one foot per second be aimed at, calculated to retain the heavy mineral, but not the organic matters.

Pumping.—(*a*) That where it is necessary to raise the sewage at the works, it is advisable that all machinery be in duplicate with alternative forms of power in case of failure.

(*b*) That appliances for raising sewage be specified with reference to efficiency in dealing with solids.

Sedimentation.—(*a*) That there be at least two sedimentation tanks.

(*b*) That such tanks be so constructed that the precipitated solids are automatically and continuously removed from that portion of the tank in which precipitation takes place, and that a tank or chamber combined with, or separate from, the sedimentation tank, be provided, into which the precipitated solids may pass by gravitation immediately following settlement.

(*c*) That consequent upon the modern requirement of the continuous removal of sludge as above stated, all base slopes of sedimentation tanks be made as near to the perpendicular as is practicable, relative to general construction.

(*d*) That the tank capacity be equal to one-fifth of the dry weather flow in twenty-four hours, or equal to three hours' flow calculated upon the twenty-four hours' dry weather flow taking place in fifteen hours.

(*e*) That the cross sectional area of the tanks provide a velocity of flow of not more than .05 foot per second, while lower velocities are preferable. Flows may be either vertical or horizontal.

(*f*) That consideration be given to the design of the inlets and outlets with a view to ensuring uniformity of flow throughout the breadth of the tank, and the absence of stagnant sections; and that all channels and parts of the tanks apart from the sludge storage area, be so constructed that no solids are retained.

Sludge Storage.—(*a*) That the overall depth of the sludge storage chamber from the surface of sewage in sedimentation tank be generally not less than fifteen feet. Greater depths may be adopted, producing a more concentrated form of sludge.

(*b*) That in deep tanks, wherever possible, provision be made for breaking up the sludge at the inlet to the sludge removal pipe.

(*c*) That the capacity of the sludge storage chamber be equal to at least four months' precipitation of sludge, containing 85 per cent. of water. Greater storage capacity is preferable as septic action is delayed in winter months. The cubic capacity of the sludge storage chamber shall be taken as only that space which is below the level of the deepest point of the sedimentation tank. In general, the average accumulation of sludge may be taken as three and a half cubic yards per million gallons of sewage on the above basis of dilution.

(*d*) That ample provision be made for the escape of gases from the surface of the sludge storage chamber.

(*e*) That pipes for the conveyance of sludge be of an internal diameter of not less than eight inches and that the inclination of such pipes, where the sludge is discharged by gravity, be at least 3 per cent. and preferably 5 per cent.

Biological Filtration.—(*a*) Where a dosing or siphon chamber is constructed to regulate the flow of the sewage over the surface of filter beds, that the capacity of such chamber does not exceed a ratio of two gallons of sewage to each square yard of filter surface. For instance, if the area of the filtering surface be two hundred square yards, the capacity of the dosing chamber should not exceed four hundred gallons, representing a dose of one-half inch depth of sewage over the whole surface of the filter.

(*b*) That the depth of the filter media be not less than four feet and preferably seven feet.

(*c*) That the filter media for effluents from the above form of tank be composed of hard broken stone or other suitable material, broken from one-inch to two-inch cubes.

(*d*) That the surface area of filtering media for domestic sewage be in proportion to the population using the sewers, i.e., in proportion to the amount of oxidizable matter present in the sewage.

Where a high degree of oxidation is required, the ratio of population to surface area of filter media should be approximately 17,500 persons to the acre (or 275 square yards per 1,000 population).

This corresponds to a rate of filtration of 1,750,000 Imperial gallons per acre per day, or 155 Imperial gallons per cubic yard per day (assuming depth of filter media to be seven feet) at a per capita flow of 100 Imperial gallons per day.

The efficiency of filters will not be materially affected by increasing the rate of filtration during periods of storm

to, say, three times the above stated rate, provided that the increase in volume is due to clear water.

In cases where the volume of dilution at the point of final discharge exceeds twenty times the volume of the sewage effluent, higher rates of filtration may be adopted.

(*e*) That the method or apparatus adopted for the distribution of liquid over the filter bed, shall ensure a uniform distribution over the whole surface.

(*f*) That all filter beds be drained at the base by tile pipes or preferably by means of a false floor over the entire base of the filter.

(*g*) That sufficient provision be made for ventilation to allow of oxygen being present at all times and in all parts of the filter bed.

Humus Settling Tanks.—(*a*) That it is generally advisable to provide settling tanks for the removal of the humus which is unloaded by the filter beds from time to time.

(*b*) That such tanks be constructed in every case where disinfection of the final effluent is adopted.

(*c*) That humus tanks have a capacity equal to one forty-fifth of the dry weather flow in twenty-four hours, or equal to twenty minutes' flow calculated upon the twenty-four hours' dry weather flow taking place in fifteen hours.

(*d*) That it is desirable that such tanks have separate storage compartments as in the sedimentation tanks above described.

Disinfection.—(*a*) That where chloride of lime is used for the disinfection of the final effluent, provision be made for weighing, measuring and storing the disinfectant in a dry covered building.

(*b*) That the period of contact between the disinfectant and the sewage be not less than fifteen minutes. An open pond or lagoon will serve this purpose.

Effluent Pipe.—That the effluent from the works be discharged into the watercourse or lake in such a manner as will ensure a maximum amount of dispersion.

Housing of Tanks and Beds.—(*a*) That all parts of the works containing sewage under treatment be housed to conserve the latent heat of the sewage during low temperatures and to prevent fly nuisance in summer.

(*b*) That such covers be designed to enclose the minimum amount of space, at the same time giving room for accessibility and inspection.

(*c*) That with properly designed covers the introduction of artificial heat is unnecessary in sedimentation tanks, and may be obviated in filter beds.

(*d*) That provision be made in all covers for the access of light and for efficient ventilation.

Laboratory.—That wherever the size of a municipality or other circumstance warrants its construction, a small laboratory be provided and equipped in which simple tests may be made of the sewage and effluents.

Laying Out the Surrounding Grounds.—That provision be made in the specifications and estimates for laying out, grading and improving the appearance of the surrounding grounds by terracing and seeding the slopes.

The Sanitation Corporation, 50 Church Street, New York City, has been organized to take over the sewage disposal interests of the T. A. Gillespie Company, the East Jersey Pipe Company, and the D'Olier Centrifugal Pump & Machine Company. The new concern will also control for the United States and Canada certain German sewage apparatus and processes, including the Riensch-Wurl screen. They will specialize in apparatus for the clarification and purification of sewage, the reduction of water content in sewage sludge and the recovery of by-products from sewage sludge.

CONTRACTION AND EXPANSION OF CONCRETE ROADS.

On February 13th, 1914, Mr. R. G. Wig, of the United States Bureau of Standards, as chairman of the committee on the contraction and expansion of concrete roads, of the National Conference on Concrete Road-building, held in Chicago, February 12th to 14th, presented a report which, among other things, brought out clearly that water as well as heat plays a vital part in the varying length of a road. The following is an abstract of the report:—

The effect of contraction may be finally evidenced by cracking and that of expansion by crushing, spalling or buckling. The engineer is interested in this subject only so far as it affects the integrity of the road. The chief causes of expansion and contraction are: (1) Changes in the temperature of the concrete; (2) variation in the moisture content of concrete; (3) variation in the condition and character of the sub-base; (4) excess loading by traffic.

Effect of Temperature Changes in the Concrete.—It is generally considered that the variation in the temperature from season to season tending to cause a change in length, combined with unequal frictional resistance between the concrete and the sub-base, is the primary cause of cracking. The change in the length of concrete due to temperature is free to move ranges from 0.00000805 to 0.000004355 per degree F. per unit length, the accepted value being about 0.000006. Assuming a normal change of temperature of 90° F., the movement which would occur without restraint is about 0.00054 per unit of length.

In practical work, however, several elements enter tending to modify the temperature effect. A reduction in the moisture content of concrete would cause a contraction, while an increase would cause expansion, thus aiding or counteracting the effect of temperature. The friction on the sub-base in the case of a road will always reduce the movement. In some recent experiments made by Henry S. Spackman upon experimental slabs of 1:2:3 concrete 18 in. wide, 6 ft. 6 in. long and 6 in. thick, on a clay sub-soil, a total movement of 0.00017 per unit length was observed under a change in temperature of 65° F. between July and November. The theoretical temperature movement for this range would be 0.000384 per unit of length.

Measurements made on a concrete road by the Bureau of Standards, covering a period from October, 1912, to October, 1913, and others from June to October, 1913, show that the linear change in the concrete is not in accord with the temperature change. These measurements were made by stretching an invar tape, graduated to meters, along the road spanning several slabs and reading every second meter, the figures recorded as slab changes represent changes between the points nearest the ends of the slab. Readings were recorded to hundredths of a millimeter (0.00039 in.) There was an elongation from November to April, when it reached a maximum, followed by a shortening until August, and this is followed by an elongation until October. During this period there was a mean temperature range from 16° to 84° F.

Considerable rain fell during the later part of March and the early part of April. The contraction from April to August is contrary to the condition which should result from a rise in temperature, and this can only be explained by a drying out of the concrete sufficient in amount not only to overcome the expansion due to a temperature increase of 20° F., but also to show a sub-

stantial contraction. From August to October the slab shows expansion, which again can be explained by an increase in moisture content as there is no rise in temperature.

There are no data available to indicate the expansion which might be expected in green concrete due to a rise in temperature brought about by chemical action during setting. Several of the curves of results obtained would indicate that this setting heat might be effective in causing expansion. Temperature measurements have been taken in a number of cases, and the temperature increases were noted to range from 17° F. to 108° F. in less than 18 hours after mixing. Such a great increase in temperature as these, it is believed, would have some effect, but its magnitude can only be determined by further investigation.

A variation in the quality of the concrete may also cause a variation in the thermal co-efficient of expansion, and it will, of course, affect the movement which takes place, as the modulus of elasticity of the concrete does change with a change in the quality.

Effect of Variation in Moisture Content of Concrete.—It has been definitely established that with an increase in moisture content there is an expansion of the concrete and with a decrease in the moisture content a contraction. This phenomena is apparently true for all concretes at all ages. The magnitude of this change is not definitely known, but experiments show:—

(1) Neat cement hardening under water expands +0.15 per cent. by volume, and the increased volume is approximately 0.08 per cent. for a period of from 30 days to five years. The maximum expansion obtained at one year is nearly as great as at five years.

(2) Neat cement hardening in air contracts 0.25 per cent. by volume in from 16 weeks to five years.

(3) Cement-sand mortars change in like manner but to a lesser degree.

Experiments by the University of Michigan show the following results:—

(1) Neat cement hardening in air has an average unit linear contraction of —0.00109 at 7 days; —0.00190 at 28 days; —0.00236 at 6 months; —0.00270 at 1 year; —0.00289 at 2 years; —0.00322 at 4 years.

(2) That neat cement that has been hardened under water for three years will expand 0.0011 per unit of length, and if then exposed to air for 60 days will contract 0.0005 per unit of length less than the initial length, and will, therefore, show a total linear contraction of 0.0016 per unit of length.

(3) That neat cements under water show a linear expansion of from 0.0007 to 0.0015 per unit of length at the end of one year, and after that a very slight additional expansion.

(4) That neat cement alternately exposed to air and water will show results if platted that will form a regular saw-tooth curve.

(5) That 1.3 mortars show linear changes in the same direction as those of neat cement, but to a lesser degree. Submerged bars show a linear expansion in the first few weeks of as much as 0.0005 per unit of length, but decrease slightly after that, and then expand later to a length greater than the maximum expansion of 0.0005. Bars of 1.3 mortar in air shrink in length to an average of 0.0008 per unit of length within three months.

(6) Experiments with sections of a top coat of a cement walk which had been laid 20 years showed that it expanded when immersed 0.0005 per unit of length and contracted the same amount when again dried.

(7) Experiments with a section of stucco two years old, from a brick house showed a linear expansion when immersed of 0.0008 per unit of length in four days, and a return to its original volume when dried.

(8) Experiments with a section of cement walk in which a sample of both the top course and base were bound together showed that upon immersion the base reached its maximum expansion in 15 minutes, while it took the top coat three days to reach the same expansion.

This is interesting, partly because of the evidence of alternate bending stress in the concrete due to the more rapid expansion of the lower layer and partly because of the ultimate agreement in expansion of the top and bottom portion. This cement sidewalk was in good condition after 20 years' service.

The results of experiments made by the Bureau of Standards are shown in Table I.

Table I.—Linear Expansion of Neat Cement Stored in Various Manners.

Test piece (1 in. by 1 in. by 13 ins.) neat cement prisms.

No. of cements.	Manner of storing.	Age of test piece.	Change in length per unit of original length
6	In water	30 days	+0.00095
8	In water	30 to 60 days	+0.00105
4	In water	120 days	+0.00113
20	In water	6 to 9 months	+0.00152
6	In air	30 days	—0.00150
15	In air	30 to 60 days	—0.00167
4	In air	120 days	—0.00211
40	In air	6 to 9 months	—0.00285

It was noted that prisms which had been stored in air, when placed in water at practically any age, began expanding, the expansion proceeding in manner similar to prisms placed directly in water after moulding. Similarly, prisms stored in water contracted when removed and kept in air.

Note.—The original reading was taken on removal from damp closet 24 hours after moulding.

Investigations have not been extensive enough to form final conclusions on the effect of moisture on expansion and contraction, but the following statements may be made, which are in part applicable to concrete roads:—

All of the tests quoted above show expansion of neat cement and of mortar and concrete when the samples are hardened under water. The results show the extent of this expansion to be greater with neat cement and to decrease when the addition of sand or coarse aggregate is made.

These tests also show that neat cement mortar and concrete will contract when hardened in air and that the contraction of neat cement is the greater, while that of mortar or concrete varies with the amount of sand and coarse aggregate used in the mixture.

They show that to an age of 20 years, and possibly for all time, these changes may be looked for in concrete.

They show that the condition which would provide for a decrease in moisture content when the temperature increases and an increase in the moisture content when the temperature decreases would be an ideal one.

All these tests indicate that the effect of moisture content is very much greater than the effect of temperature change, and may be sufficient to cause a stress in the concrete opposite to that which would be caused by a normal temperature change.

A variation in the quality of the concrete will cause a variation in the tendency to expand and contract with change in moisture content, as dense mixtures absorb water less rapidly than porous mixtures.

If concrete of two qualities in a road were exposed to an equal amount of moisture for a short period, the more porous of the two would have a tendency to expand the most and would have the less strength to resist the stresses set up. Assuming only a slight change in temperature and that the frictional resistance on the sub-base was uniform, the more porous concrete would have to move the greater distance, higher tensile stresses would be set up upon drying out, and it would be the more liable to crack.

If 1-course work concrete of two qualities in the same slab in a road were similarly exposed, the same tendency would be exhibited, and this may, in certain cases, be sufficient to cause a separation of the two concretes or may cause a number of small cracks.

If in 2-course work the base is of a more porous concrete than the top, the tendency would be to have unequal expansion and contraction in the slab, due to different moisture content in these mixtures causing the bottom to move more than the top or vice versa. Also, if the concrete road is subject to a heavy rain for a considerable length of time the bottom will be exposed to moisture in the ground for a longer time than the surface and the surface will be more or less dried, due to exposure to the sun, and, consequently, the top would tend to contract while the bottom would still be expanding.

Effect of Variation in Condition and Character of Sub-base.—The condition and character of the sub-base would affect the support of the road; the amount of moisture transmitted to and from the concrete; the action of frost; and the friction on the bottom of the slab. All of these factors affect the expansion and contraction of the concrete.

If the slab of concrete is not uniformly supported, sections may be stressed, causing tension or compression in an amount sufficient to exceed the strength of the concrete, resulting in cracking. A condition illustrating this point may be found where a concrete road is built over an old stone road-bed of less width than that of the concrete slab. The foundation at the sides, which is not so compact as that at the centre, will settle more, causing expansion in the surface of the concrete slab possibly sufficient to cause a crack. While there is no experimental data available definitely establishing this point, it is believed the longitudinal cracks noted in one of the roads under examination may be thus accounted for.

The amount of moisture transmitted to and from the concrete through the sub-base depends upon the porosity and density of the material in the sub-base. The action of frost can only occur in a sub-base containing moisture in localities in which the temperature gets sufficiently low to freeze to a depth of the sub-base. This action is, therefore, dependent upon the porosity and capillarity of the sub-base material and the depth of the water table below the concrete. The effect of freezing and thawing is to place the slab in stress which may cause cracking.

From observations made it would appear that the cracks usually occur during a thaw rather than during a frost, and this may be explained by the fact that the heat may be transmitted more rapidly through the shoulders than through the centre of the road, causing unequal settlement. If the heaving action of frost does cause cracking it is usually due to raising the edge of the road, which will probably crack the lower side, which may not be apparent until the slab returns to its original position, when the crack will appear on the upper surface.

The friction on the bottom of the slab is dependent upon the condition of the sub-base. The effect of this friction is to restrain movement in the concrete; therefore, the tendency to volumetric change due to change in moisture content and thermal change would be restrained. This restraint would set up stresses in the concrete probably proportional to the restraint. This is shown in the experiments made by Mr. Spackman. Referring to these results and considering only the effect of temperature, there should have been a theoretical movement of 0.000384 per unit length, and yet only a movement of 0.00017 per unit length was obtained. An inspection of the movements recorded in Figs. 1 to 3 also shows that the movements were not in accordance with theoretical requirements. The change in moisture content is not known, and most probably had something to do with the discrepancies. Thus, the actual movement observed by Mr. Spackman due to temperature may have been greater or less than that indicated by the figures.

The longitudinal grade of the road would affect the friction on the bottom of the slab. On a 5.2 per cent. grade a slab 30 feet long was observed to have moved down hill, the joint at the upper end of the slab being decidedly open while the lower end of the slab slid upward on the adjoining slab. The joint in this case was not perpendicular to the slab. Measurements also substantiate the above conditions. This sliding may have been assisted by changes in the thermal and moisture content of the concrete.

Effect of Traffic.—The expansion and contraction of concrete is probably the least affected by loads brought upon the road by traffic than by any of the above mentioned causes. The effect is, however, not to be neglected, particularly when it acts in conjunction with an uneven settlement of the sub-base, similar to that heretofore mentioned of a slab being placed over an old stone road of less width than that of the concrete. The result would be cantilever or beam action and the consequent throwing into tension the top of the slab, which may cause cracking.

[Note.—The balance of the report dealing with the application of present knowledge to the prevention of cracks; the value of reinforcement; the effect of joints, and of character and condition of the sub-base on cracking, will follow in next issue.—Editor.]

BELL FILTRATION COMPANY SUES THE EX-MAYOR OF OTTAWA.

The Bell Filtration Company of Canada, Limited, have entered suit against ex-Mayor Ellis, of Ottawa, Ont., for $10,000 damages. Mr. Ellis, who is now an alderman of Ottawa, was defeated in the mayoralty contest early this year by Mayor McVeity.

Alderman Ellis is a strong advocate of the Gatineau Lake water scheme for Ottawa, while Mayor McVeity prefers filtration. Interviews and other matter published in the Ottawa papers tending to have an influence on the plebiscite which was to have been taken March 9th, are the cause of the suit.

The Bell Filtration Company contend that the cost of a filtration plant for Ottawa plus the capitalized cost of operation, is far less than the cost of the Binnie or Gatineau Lake scheme plus the cost of operation. It was in opposing these arguments and urging the people to vote for the Binnie scheme, evidently, that the former Mayor made statements which led to the institution of the suit for damages.

The Cleveland Bridge and Engineering Company has secured from the Argentine Government the contract for the erection of a great new reservoir at Caballio, in connection with the water supply of Buenos Ayres. Leading American, Belgian and German structural engineering firms submitted tenders.

THE CONTROL OF STREAM POLLUTION.*

By Paul Hansen,
Engineer, State Water Survey, Urbana, Ill.

IN uninhabited or even rural districts the evil results of stream pollution are practically negligible, but in urban districts streams are rendered exceedingly foul by the enormous quantities of sewage and industrial wastes poured into them from city sewers. These streams become totally unfit for pleasure purposes, the land along the banks is depreciated in value, and public water supplies drawn from the streams may be grossly contaminated and constitute an extreme danger to public health. An enormous toll in human lives is annually exacted as a result of polluted streams, not to mention the economic loss due to depreciation in property values.

To prevent the evils of stream pollution gaining too great headway, central governmental control backed by an intelligent public opinion is essential. The molding of an intelligent public opinion is, however, a rather difficult matter, for even among persons who have given considerable thought to sanitary subjects, there exist gross misconceptions as to the logical and practicable way to treat the problem of stream pollution. There has been a tendency to permit sentimentality to get the upper hand, and this has resulted in giving wide currency to some extravagant demands that are wholly impracticable. There is, however, a group of sanitary engineers who have come into intimate contact with actual problems relating to the prevention of stream pollution, and among these engineers there has gradually come about a unanimity of opinion regarding certain essential factors relating to the stream pollution problem. It will be the object of this paper to present these opinions, and the statements made will be largely based upon recent careful inquiries among sanitary engineers and others interested in sanitation.

The subject may best be treated by first considering in a broad way what the functions of a stream really are. Having reached a satisfactory conclusion upon this point, it will be possible to consider certain special uses of streams with respect to stream pollution.

General Functions of Streams.—The proper conception of a stream recognizes the dual function of watering and draining the country through which it passes. Some pollution of streams is inevitable; for with increased density of population, increased cultivation of the soil and increased numbers of urban communities, it is practically impossible to prevent the discharge of all deleterious matter into streams. It is only reasonable to require that the pollution of streams be maintained at less than a certain fixed maximum, and this permissible maximum pollution must vary according to the character of the stream, the population along the banks of the stream and the uses to which the waters of the stream are placed.

Streams Used as Sources of Public Water Supplies.—Since streams in the ordinary course of events must receive more or less contamination, it follows that public water supplies drawn from surface streams must of necessity be polluted, and should not be delivered to the consumers unless the water is first adequately purified. One exception may be made to this general rule, namely, in the case of water supplies derived from streams draining comparatively small watersheds. In such cases it is sometimes feasible for the water supply authorities to own the entire watershed and control it in such manner as to make contamination of the water courses impossible. But in general we have this question to contend with: How much pollution may be permitted to enter a stream before the water thereof is polluted to a point beyond redemption by water purification methods? This is a question that taxes the greatest ingenuity of sanitary experts, and it is always necessary for any specific problem to be considered on its particular merits in order to obtain what is the best and most economical solution.

Notwithstanding the great difficulty in defining that degree of pollution which is permissible in streams which are to be used as public water supplies after purification, there would seem to be an advantage in attempting to approximate a general rule for the control of such streams. A rule has been formulated in the light of the present available evidence, but it must be admitted that this rule is not based upon any very scientific data and it can, therefore, only be put forward tentatively, with the expectation that it will be modified from time to time as more and more experience is acquired. This rule may be stated as follows:

The time in hours required for the passage of a particle of water from a sewer outlet to the point of waterworks intake during high water multiplied by the dilution available during low water in cubic feet per second per 1,000 persons tributary to the sewers should equal a constant and this constant should not equal less than 40. This may be expressed mathematically as follows:—

$$T + D = C.$$

In which T = time in hours required for the passage of a particle of water from the sewer outlet to the waterworks intake at high water;

D = dilution available during low water in cubic feet per second per 1,000 persons tributary to the sewers; and

C = constant which it is recommended be not less than 40.

The above formula applies to streams in which there is no appreciable increase in volume of flow between the sewer outlet and the point of waterworks intake. In the case of streams which receive the discharge of large tributaries between the point of sewer outlet and the point of waterworks intake, the formula must, of course, be modified. Generally it will be merely necessary to assign a value of D, which represents the mean of the quantity of water flowing past the sewer outlet and that flowing past the waterworks intake. If the factor of safety proves to be more than 40, purification of the sewage will not be necessary for the protection of the water supply. If the factor of safety is less than 40, some form of purification will be necessary, and this may vary all the way from plain sedimentation to intermittent sand filtration followed by sterilization.

The formula, of course, is intended to be used merely as a rough guide, and it is conceivable that there are instances where it will not apply. Take, for example, the case of a very large stream, where a sufficiently large factor of safety may be obtained with the sewer outlet at a very short distance above the point of waterworks intake, and on the same side of the stream; here it is manifest, due to the impracticability of securing a mixture of the sewage with the entire volume of the stream, that the sewage must receive treatment or the waterworks intake must be extended to a point above or, at

*From a paper read at the 1913 convention of the Illinois Academy of Science.

any rate, beyond the influence of the sewer outlet. As a rough guide, however, such a formula may serve a useful purpose in narrowing down the widely divergent practice of the present time.

Streams for Recreation Purposes.—Of recent years growing importance is attached to the maintenance of our streams for pleasure purposes. Every summer there may be found scattered along the streams within a radius of fifty miles or more of our large cities numerous camps. This form of summer vacation is a comparatively cheap and normally a healthful means of recreation. It ought to be regarded as one of the means of improving the health tone of our urban communities, inasmuch as it is within the means of so great a number of people.

Under this head may be asked how high a degree of purity should be demanded in a stream which is extensively used for recreation purposes, but not for public water supply? Within the last few years much emphasis has properly been placed upon the purification of sewage by dilution, which, after all, is purification by oxygenation in which a natural resource is utilized instead of an artificially constructed purification works. It has generally been held—and in most instances rightly held—that the degree of dilution necessary is merely that which will prevent a nuisance, having reference primarily to unsightly floating matter and bad odors. For most rivers and many of the smaller streams of the country, this requirement as to the cleanness of the waters is all that is necessary.

There is, however, a certain class of streams which, because of the beauty of the country through which they flow and their specially favorable location, become highly prized for camping and recreation purposes. It is a striking circumstance, in fact, that recreation seekers nearly always look for the stream valleys, which illustrates the craving of man for a combination of land and water, by means of which nature presents her most alluring and most picturesque aspects. These streams, as a rule, have no large cities upon their banks, but merely here and there a small town or village. The sewage from such small towns and villages may not be sufficient to produce a visible contamination except possibly throughout a very short distance below the sewer outfalls. Such contamination does offend the esthetic sense, however, and undoubtedly does add some danger to public health, for the reason that, when a stream is used for recreation purposes, it will be used for boating and bathing and as a domestic supply to some extent among campers, though it may not and should not be used for drinking water. It seems to the writer that such streams as these deserve greater protection against contamination than merely to prevent nuisance.

No definite rules to apply to all cases can be laid down, but as a general principle it may be said that if such a stream is not polluted to any material extent by storm water and street wash, such as would obtain in the case of a city of considerable size located upon its banks, it would seem perfectly feasible to purify the sewage to a point where it will give no evidence of its existence even in the vicinity of the outlet. Furthermore, the sewage effluent should be sterilized by the cheap and satisfactory means of using bleaching powder, so as in large measure to guard against dangers to health among vacationists which may result from boating, bathing and domestic uses of the stream other than for drinking.

Fish and Shell Fish.—Many streams are valuable to the community on account of their fish life. It may be said, in general, that there is rarely necessity for so polluting a stream as to endanger fish life, though there are some circumstances where the continuance of certain liquid-waste-producing industries injurious to fish is of so great importance to the general welfare that fish life in certain streams must be sacrificed.

The maintenance of fish life does not necessarily imply an unpolluted stream. It is merely necessary that the alkalinity of the water be maintained and that the pollution be not so great as to absorb the dissolved oxygen in the water to an extent that will suffocate the fish. The fact is that a moderate degree of pollution favors fish life, in that it favors the growth of microscopic aquatic organisms which constitute valuable fish food. Certain difficulties have been encountered in the contamination of fish by polluted water which causes the fish to decay rapidly and become unfit for human consumption. The danger of infection of human beings with specific disease through eating fish taken from polluted streams is almost negligible, for the reason that, in this part of the world, at any rate, fish are not eaten raw. With shell fish, however, the case is quite different, because they are very frequently eaten raw. It has been a common practice along the coast to float oysters in shallow polluted waters, which causes them to become bloated and appear fat. Such an oyster perhaps makes a more delectable morsel of food, but in it may be lurking the germs of typhoid fever or some other waterborne disease. The problem of protecting the shell fish industry is a very complicated one, and all its intricacies have not been worked out. Here, again, the services of experts are needed to study each zone of shell fish pollution in the light of diverse local conditions.

Discharge of Manufacturing Wastes Into Streams.—Many of our important industries, such as paper mills, woolen mills, dye works, starch factories and tanneries require large volumes of water to carry on their industrial operations, and they also produce large volumes of waste which are capable of undergoing offensive putrefaction. The discharge of these wastes into streams often causes unsightly and malodorous conditions; yet, with the exception of tanneries, these waters do not menace the public health, since they do not contain the specific infections of disease. (Tannery wastes may contain anthrax bacilli.) In fact, some of the processes are such that the wastes are quite inimical to the existence of disease germs. In some cases it is practicable to treat the wastes so that offensive conditions in a stream may be in part or wholly relieved, but for certain industries such treatment of the wastes is prohibitively expensive.

Enjoining industries against causing objectionable stream pollution may, and in some instances actually has, necessitated the shutting down of works. It is conceivable, in the case of large industries upon which are dependent a considerable population, that an order to cease stream pollution, which is virtually an order to shut down the works, might result in great hardship without adequate returns accruing from the cleaner conditions of the stream. There may be instances, therefore, where a limited few of the streams of the country may legitimately be turned over to the manufacturing interests. Now that the stream pollution problem has become more acutely an issue and the disadvantages of filthy streams are better understood, it would not seem wise to permit waste-producing industries to be located upon any but very large streams which have an ample volume to dilute the wastes to an inoffensive condition. That is to say, the streams which are now clean should be maintained clean, for the reason that we have an ample number of

large streams which can effectually take care of wastes from waste-producing industrial plants for an indefinite period in the future.

Legal Control Over Stream Pollution.—A discussion of stream pollution would not be complete without some consideration of legal control. As already indicated, the cleanness of streams cannot be conserved unless under a central governmental supervision. If left to individual communities, very little could be expected in the way of results. Communities are not likely to be altruistic enough to spend large sums of money for sewage purification works to protect neighbors on the stream below, unless such altruism is induced by damage suits which render sewage purification the cheapest way out of the difficulty. But law-suits are costly if long drawn out, and the results are often unsatisfactory.

For successful solution it is essential that specific problems relating to stream pollution be placed in the hands of experts. It is, therefore, necessary, or at least strongly advisable, that every state have an expert commission. Among many there is a strong prejudice against commissions, inasmuch as the multiplication of commissions is looked upon as a delegation of legislative and executive powers to others than direct representatives of the people. This need not necessarily be so, however, for a law may be framed requiring in general terms that streams must be maintained in an inoffensive condition and that they shall not be detrimental to health. This leaves to the commission not arbitrary powers, but the simple function of determining points of fact within limits prescribed by prior legislative enactment. That is to say, the commission will determine when a stream is in danger of being made offensive and when it is in danger of being made detrimental to health, and thereupon decide what purification of sewage and industrial wastes is necessary, whether water supplies may or may not be taken from streams and to what extent they must be purified. Such a commission should be supplied with ample appropriations to enable it to obtain all necessary information for its guidance, whether this consists in maintaining laboratories or in carrying on experimental and research work. As even the best of commissions may at times grow arbitrary or become unduly biased in its views, there should always be made provision for ready appeal from the decisions of a commission to an independent special arbitration board of experts, and, of course, there must exist the inalienable right of appeal to the courts.

The Berlin Elevated and Underground Railway, Berlin, Germany, has recently completed, at a cost of over $2,000,000 and has opened for public service, an extension from Wittenbergplatz in Berlin to the fashionable suburb of Dahlem.

One of the most wonderful structures of its kind, and one that is said to be the only large-span bridge in the world designed for four lines of railway traffic, is the Hell Gate steel arch bridge now under construction at New York. The Long Island abutment pier is well under way and the foundation for the Ward's Island pier is complete. Fabricated steel work is already being received and the erection of the arch will probably be under way before the end of the summer. The structure will be notable for the magnitude of its chord sections. Each single section will have a weight equal to twice that of the heaviest erection parts of the great bridges already existing. The weight of the structure will average about 38,000 pounds steel and 53,000 pounds total per lineal foot. The great weight is due to the large live-load capacity provided. When it is in operation there will be a constant succession of the heaviest freight trains passing back and forth over the structure.

THE MINERAL PRODUCTION OF CANADA, 1913.

The preliminary report on mineral production in Canada in 1913, prepared by John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics, shows a total value of production in the year of $144,031,047. Although estimates have been made in some cases where complete returns were not available it is probable that the final record will be a revision upward. The total value of the production in 1912 was $135,048,296 compared with which the 1913 output shows an increase of $8,982,751, or 6.65 per cent. In view of the large increase over all previous years made in mineral production in 1912 and the general trade depression and industrial restriction experienced during the latter part of 1913, the industry would appear to have made in the aggregate very satisfactory progress. The average production per capita in 1913 was $18.57 as against $18.27 in 1912 and $14.93 in 1910.

The record of annual mineral production in Canada since 1886 shows the rapid growth of the industry; not only has the total output increased from a little over $10,000,000 in 1886 to its present output, but the average production per capita has increased from $2.23 per capita to $18.57, or eight times the rate shown by the first record. This is shown in Table I.

Table I.—Annual Mineral Production in Canada Since 1886.

Year.	Value of production.	Value per capita.	Year.	Value of production.	Value per capita.
1886..	$10,221,255	$2.23	1900..	$ 64,420,877	$12.04
1887..	10,321,331	2.23	1901..	65,797,911	12.16
1888..	12,518,894	2.67	1902..	63,231,836	11.36
1889..	14,013,113	2.96	1903..	61,740,513	10.83
1890..	16,763,353	3.50	1904..	60,082,771	10.27
1891..	18,976,616	3.92	1905..	69,078,999	11.49
1892..	16,623,415	3.39	1906..	79,286,697	12.81
1893..	20,035,082	4.04	1907..	86,865,202	13.75
1894..	19,931,158	3.98	1908..	85,557,101	13.16
1895..	20,505,917	4.05	1909..	91,831,441	13.70
1896..	22,474,256	4.38	1910..	106,823,623	14.93
1897..	28,485,023	5.49	1911..	103,220,994	14.42
1898..	38,412,431	7.32	1912..	135,048,296	18.27
1899..	49,234,005	9.27	1913..	144,031,047	18.57

The continuance during 1913 of the labor strike at the mines of the Canadian Collieries (Dunsmuir) Limited, and its extension to the other collieries on Vancouver Island, seriously restricted the coal output from that district. The total value of the metals was also somewhat smaller than it might otherwise have been because of the slightly lower average prices obtained for copper and silver. A restricted demand was also reported during the latter part of the year for brick and other clay products and structural materials. While these are some of the influences that have tended to curtail the mineral output during the year, there have been, on the other hand, important increases in the production of gold, nickel, lead, amongst the metals, in asbestos, natural gas and many of the other lesser valuable non-metal products and in cement, resulting in the net increases already shown.

The production of the metals and minerals of special importance to engineers, contractors and manufacturers of their supplies is shown in Table II., in which the figures are given for the two years 1912 and 1913 in comparative form, and the increase or decrease in value shown.

Of the total production in 1913 a value of $66,127,821 or 45.9 per cent. is credited to the metals and $77,903,226 or 54.1 per cent. to the non-metallic products. The increase over the value for 1912 in metallic products was $4,955,068 or 8.1 per cent. and in non-metallic products $4,027,683 or 5.45 per cent.

Mineral Production by Provinces, 1912 and 1913.—The record of production by provinces given in Table III. shows the relative importance of the several provinces in practically the same order as last year with the exception that Saskatchewan replaces New Brunswick in last position due to a falling off in the coal and structural material production in the former province and an increase in the coal, gypsum and natural gas production in the latter. Ontario has the largest output with a value of $58,697,602, or 40.75 per cent. of the total, a slightly higher proportion than in 1912. British Columbia is second with a value of $28,529,081, or 19.81 per cent. of the total, a relative falling off; Nova Scotia takes third place with a total production of $19,305,545, or 13.4 per cent.; Alberta fourth, with $13,844,622, or 9.6 per cent.; Quebec fifth, with $13,303,649, or 9.24 per cent.

Table II.

	—1912—		—1913—		Increase (+) or decrease (—) in value.
	Quantity.	Value.	Quantity.	Value.	
		$		$	$
Pig iron ....(Short) Tons.	1,014,587	14,550,999	1,128,967	16,540,012	+1,989,013
Lead ....Lbs.	35,763,476	1,597,554	37,662,703	1,754,705	+ 157,151
Nickel ....Lbs.	44,841,542	13,452,463	49,676,772	14,903,032	+1,450,569
Asbestos and asbestic ....Tons.	136,301	3,137,279	161,086	3,849,925	+ 712,646
Coal ....Tons.	14,512,829	36,019,044	15,115,089	36,250,311	+ 231,267
Gypsum ....Tons.	578,458	1,324,620	639,698	1,477,589	+ 152,969
Natural gas ....M. ft.	15,286,803	2,362,700	20,345,763	3,338,314	+ 975,614
Petroleum ....Bbls.	243,336	345,050	228,080	406,439	+ 61,389
Salt ....Tons.	95,053	459,582	100,791	491,280	+ 31,698
Cement ....Bbls.	7,132,732	9,106,556	8,658,922	11,227,284	+2,120,728
Clay products	....	10,575,869	....	9,673,067	— 902,802
Lime ....Bush.	8,475,839	1,844,849	7,671,381	1,605,812	— 239,037
Stone	....	4,726,171	....	5,199,204	+ 473,033

There was an increased production of each of the metals except copper and silver, the most important increase being in gold with 28 per cent. Pig iron increased 11.3 per cent. in tonnage, lead 5.3 per cent., and nickel 10.8 per cent. The falling off in copper was only 1.1 per cent. in quantity although 7.6 per cent. in total value, and for silver 0.6 per cent. only in number of ounces and 2.3 per cent. in value, slightly lower average prices having been obtained for these metals.

Amongst non-metallic products increases are shown in all the important products except clays and lime. The largest increase was in natural gas with 41 per cent. in value. The cement output was greater by 21 per cent. in quantity, asbestos 18 per cent., coal 4 per cent., gypsum 10.5 per cent., salt 6.04 per cent. In the case of petroleum there was a falling off of 6 per cent. in quantity but on account of higher prices an increase of nearly 18 per cent. in total value.

The decreases in clay products and lime were respectively 8.5 per cent. and 12.9 per cent.

Table III.

	—1912—		—1913—	
	Value of production.	Per cent. of total.	Value of production.	Per cent. of total.
	$	%	$	%
*Nova Scotia ..	18,922,236	14.01	19,305,545	13.40
New Brunswick.	771,004	0.57	1,049,932	0.73
Quebec	11,656,998	8.63	13,303,649	9.24
Ontario	51,985,876	38.50	58,697,602	40.75
Manitoba	2,463,074	1.83	2,211,159	1.54
Saskatchewan ..	1,165,642	0.86	899,233	0.62
Alberta	12,073,589	8.94	13,844,622	9.61
British Columbia	30,076,635	22.27	28,529,081	19.81
Yukon	5,933,242	4.39	6,190,224	4.30
Dominion ..	135,048,296	100.00	144,031,047	100.00

*Includes a small production of lime from Prince Edward Island.

Increases are shown in each of the provinces with the exception of Manitoba, Saskatchewan and British Columbia. The largest increase—36 per cent.—is exhibited by New Brunswick. The increases in the other provinces were respectively: Alberta, 14.7 per cent.; Quebec, 14.1 per cent.; Ontario, 12.9 per cent.; Yukon, 4.3 per cent.; Nova Scotia, 2.0 per cent. The decreases were Saskatchewan nearly 23 per cent.; Manitoba 10 per cent., and British Columbia 5 per cent.

It should be remembered in dealing with these comparisons that Nova Scotia in the above record is given no credit on account of the large iron smelting and steel making industries at Sydney, New Glasgow, etc. The pig iron made here is entirely from imported ore and naturally is not credited as a Canadian mine output. The same remark applies to a large percentage of the pig iron production in Ontario as well as to the production of aluminium in Quebec.

A resolution was passed by the Canadian Mining Institute at Montreal on March 6, directing the attention of the Dominion Government to the fact that the iron industry was greatly handicapped because extensive deposits of the same high grade as were found in the United States, Newfoundland and Cuba had not yet been located in Canada, although it was believed that they existed, and that they could be found should endeavours be made. The Institute, therefore, urged the Government to take such means through the proper channels, either by a geological survey or by a special committee of experts, as would determine the extent and value of Canada's iron resources, a procedure which would add immensely to the economic wealth of the Dominion.

Coast to Coast

Edmonton, Alta.—It has been reported at Edmonton that the total deficit in 1913 for the street railway department amounted to $190,000.

Guelph, Ont.—The Fire and Light Committee at Guelph are asking the city council for an appropriation of $31,471, which is in excess of the largest amount ever requested previously.

Halifax, N.S.—At the session of the Nova Scotia government on March 4th, it was announced that during the last fiscal year there had been a total expenditure in the roads division of the department of public works of $408,090.37, the largest expenditure in any year since the organization of roads division.

Halifax, N.S.—The report on provincial railways recently submitted in the Nova Scotia legislature showed that the increase in total earnings of the subsidized railways in the province for the fiscal year 1913 was $126,835.71, or about 8 per cent. over the total earnings of 1912. Except for 2 miles of new railway built by the Dominion Coal Co., Limited, there has been no railway construction during the past year over which the province had jurisdiction.

Winnipeg, Man.—It is estimated, according to a statement presented at a recent meeting of the administration board of the Greater Winnipeg water district, that the sum of $1,332,906.29 will be spent by the end of the year on the scheme to bring Shoal Lake water into the city. The estimated expenditure by months is as follows: To March 1, 1914, $108,799.34; to April 1, $138,046.04; to May 1, $168,816.04; to June 1, $221,026.04; to July 1, $334,110.29; to August 1, $501,580.29; to September 1, $690,395.29; to October 1, $814,815.29; to November 1, $1,057,466.29; to December 1, $1,293,606.29; to January 1, 1915, $1,332,906.29.

Vancouver, B.C.—It is stated that more than 1,000 feet of the "pioneer" bore, being driven by the C.P.R. in connection with the excavation of a 5-mile, double-track tunnel through the heart of the Selkirk range, have been completed. Good progress is also being made with the cross cuts and side drifts leading into the main shaft which has already been started from the east end. Work on the "pioneer" shaft from the west side of Mount Macdonald, will most likely be started at an early date. The right-of-way at the west portal has been completed and 47 per cent. of the excavation has been done from the east side. Work on the trestles and the grading for the lines on each side of the mountain is well advanced.

Edmonton, Alta.—Compilations made by the Edmonton Industrial Association show that at least 3,000 miles of railway will be built in Alberta before the close of 1915. The C.N.R. will construct 1,000 miles, most of which will be in the northern half of the province; though it will also complete its main line in western Alberta. The C.P.R. will continue the Calgary-Edmonton line northward into the Peace River country and other northern and central sections, as soon as a survey is approved. It is stated by the president of the Edmonton, Dunvegan and British Columbia Railway Company that 125 miles of the 283 miles of road from Edmonton to Fort McMurray will be ready for grading early in May. Also work is to begin this year in the three western provinces on a line from the Ness River on the Pacific Coast, to Prince Albert, Sask., by way of Northern Alberta.

Victoria, B.C.—A settlement has been reached with the Canadian Northern Pacific Railway and the Franco-Canadian syndicate for the lease of the six acres required at Cooper's Cove to the Pacific Lock Joint Company for the purpose of drying out the pipe to be used on the waterworks flow line. The company's agents are assembling material and supplies at the Cove and this contract, the largest and most important of those to be carried out in connection with the waterworks, will be under way in a short time. Meanwhile the city is pushing the work on the trestles, which have to be made of a permanent character before the pipe is laid upon them. At present frame structures carry the track across creeks and ravines, except Sooke River, where a steel span is necessary.

Calgary, Alta.—In addition to the plans recently submitted by the City Engineer of Calgary upon the bridge at Centre Street, plans have also been provided for bridges known as Louise Bridge and Mission Bridge. The plans for the former call for a reinforced concrete bridge to replace the present structure, 600 feet long, landing just east of the present structure so that it debouches into 9th Street, at a cost of $167,000; or for a duplicate of present steel bridge, but two feet wider, to be placed directly alongside and coupled up with the present bridge, making a double steel bridge, one for north-bound and the other for south-bound traffic. This is estimated to cost $55,000. The plans for the Mission bridge are for a reinforced concrete structure, with 46-foot roadway and two 8-foot sidewalks, estimated at $77,600; or for a steel lattice girder bridge, with ornamental railing, estimated at $67,000.

Calgary, Alta.—Three separate plans and estimates have been furnished by City Engineer Craig, of Calgary, for a bridge at Centre Street, and these are now being considered by a special committee of the city council. Mr. Craig has arranged all three plans so that the south approach can start from either Centre Street or First Street West. Alternative plans are also provided for the North Hill approach. These will be either through an open cut running back into the hill some distance and bridged over at street crossings by overhead bridges, or else the approach in the north hill can be tunnelled for a short distance through the hill. The difference in cost between the tunnel and the overhead bridges will be about $3,000 in favor of the bridges, according to the engineer's estimates. The plans for all the bridges provide for length of 900 feet. The plans also provide for 40-foot roadways with two 8-foot sidewalks.

Woodstock, N.B.—Preparations for the spring work on the St. John Valley Railway are in progress. It is announced that Messrs. Kennedy and McDonald, who have an option on the section from Centreville to Grand Falls, but which contract has not been let, will have a new 100-ton steam shovel on the work by April 1st, to supplement the smaller shovel which has been used between Woodstock and Centreville. Ballasting south of Woodstock will commence on May 1st. The Dominion Bridge Company is constructing the overhead crossing at Woodstock, which is an 80-foot span, and will soon commence work on the Meduxnakik Creek bridge, which is 380-foot span, and which will probably be finished by the middle of April. The brick station at Woodstock will have a concrete foundation, and will be 140 feet long by 40 feet deep. The tenders are now in and the contract will be given and work commenced as soon as the frost is out of the ground.

Ashcroft, B.C.—One of the most difficult bridges from a construction point of view on the Canadian Northern Pacific Railway in British Columbia is approaching completion. The viaduct spans the Black canyon, a narrow gorge on the Thompson River, a few miles below Ashcroft, and 189 miles east of Port Mann. It had to be built without the aid of false

work; and the fact that the railway entered a 1,300-foot tunnel after spanning the canyon greatly increased the engineering difficulties experienced in its erection. An abutment was built on the tunnel side and the massive steel girders were placed in position by means of a huge derrick, which swung over the gorge. The main span of the bridge is 210 feet long, the total length of the structure being 245 feet. It rests on a pier which is nearly 100 feet down to rock; and it is built of truss girders and of the most substantial type. At low water the railway will cross the canyon at a height of about 80 feet.

Vancouver, B.C.—The preliminary work in connection with the dock upon which construction has commenced for Messrs. McNeill, Welsh and Willson, of Vancouver, consists of the erection of a wharf 308 feet long by 176 feet wide, a roadway approach, and the reclamation of a tract between the proposed dock and the railway bridge. The plans which have been prepared by Messrs. J. R. Matheson and Sons for the sheds and warehouse buildings to be constructed provide for two large structures 204 feet long by 75 feet wide, which will flank a central roadway and "gridiron" landing slip for scows. Additional loading facilities for barges will be provided on the western side of the wharf, and the reclaimed area between the eastern edge of the dock and the railway bridge will be utilized for trackage purposes. A strip 50 feet wide will be filled in, to connect the dock with the bridge. The warehouses will be of substantial construction and covered with galvanized iron. The roadway and the scow landings will also be enclosed. The dock will be approached by a driveway 200 feet long. A feature of the sheds will be the absence of pillars, massive trusses being used to support the roof.

Brandon, Man.—A joint power committee was formed in Brandon on March 5th, and at its session on the following day passed three resolutions, the first proclaiming that the committee recognized the importance to Manitoba of the preservation of the water powers on the Winnipeg River, and that it be represented to the government of this province that it is necessary in the provincial interests that the province vigilantly guard the rights of the province in the matter of the water flow on the said river. The second motion proposed that it be respectfully represented to the government of the province that is is expedient in the interests of this province that the matter of the distribution of electrical energy to the towns and villages, and as far as possible to the rural municipalities of this province, be made the continuous study of those experts in hydraulic and electrical engineering, and that it be represented that the matter may be a fit one upon which to invoke the continuous thought and attention of the engineering branches of the Manitoba university. The third resolution provided for securing an itemized statement of the power used between Portage and Carberry, and the same information regarding Carberry.

Victoria, B.C.—The report of the first year's work of the Water Rights Branch of the Provincial Department of Lands was given recently in the British Columbia Legislature by the Hon. W. R. Ross, Minister of Lands. He stated that a definite order of work was adopted and followed throughout the season in all the water districts into which the Province has been divided on the following basis:—Engineering investigation of old records; systematic and continuous work in stream measurement; a study of the proper duty of water; the prevention of wasteful use of water; the policing of streams; the economic distribution and delivery of water; the inspection of cisterns to determine their efficiency and safety; the determination of storage possibilities; and the investigation of water powers; also the chief draughtsman of the Water Rights Branch reports that a series of standard water rights maps, on a scale of 20 chains to the inch, has been inaugurated, and 228 of these have been drawn in 15 of the new water districts, each showing about 35 square miles, making a total of 8,000 square miles covered. Reports of engineers of the several districts are also submitted together with a series of valuable tables dealing with hydrographic stream measurements and a number of maps and diagrams showing the work of the department.

Montreal, Que.—During last summer about 60 miles of the 132 miles of macadamized road which the Quebec Government is building between Charlemagne and St. Augustin on the north side of the St. Lawrence River was levelled, and this year Mr. H. Beauregard, general contractor for the work, expects to have that district entirely completed. By next fall, it is expected that the completed road will extend as far as Berthier, which will exceed the 30 miles stipulated in the contract by 3½ miles. Mr. Beauregard has sub-let the eastern portion of his contract to Messrs. Massicotte and Gagnon, and is supervising personally the western section, or that which extends from Charlemagne to within 3½ miles of Berthier. The line for the greater part of the distance will be in full view of the St. Lawrence. Generally speaking, the old high roads are utilized, but where the grade is somewhat heavy the line deviates, the land being expropriated by the department having charge of the important work. Hundreds of gullies and ravines have to be crossed, but the statement was made yesterday by Mr. Beauregard himself that the remarkably favorable grade of 2 per cent. would be maintained throughout the entire road except a short distance near the Jacques Cartier River on the lower end of the contract. Besides the 30 miles from Charlemagne or more which the contractor expects to hand over this fall he will also level and additional stretch and everything will be done so as to secure the certainty of a completed road by the fall of 1915, the time specified in the contract.

Victoria, B.C.—The bill giving further aid to the Pacific Great Eastern Railway Company has passed its second reading in the Provincial Legislature. It provides for 30 miles of railway at $35,000 a mile, constituting an additional mileage over the 450 miles named in the original agreement between the Government and the company. This extra mileage is due to the fact that a deviation in the route was made by the engineers in the neighborhood of Clinton, as the route along the Fraser River was found not to be a feasible one, and the new alignment opened up a new section for settlement. It also provides for an increase of $7,000 per mile over the entire mileage of 480 miles, thus raising the guarantee to $42,000 a mile over the entire distance; and for 330 miles at $35,000 a mile into the Peace River country. The average cost of the Pacific Great Eastern is over $58,000 per mile, according to the estimates recently prepared by the engineers. This brings the total cost to about $27,840,000. If the guarantee is raised to $42,000 per mile, it will leave $16,000 a mile to be found by the Pacific Great Eastern, or an aggregate of $7,680,000. The whole length of the line between Vancouver and Clinton is of very heavy construction. The cost from the head of the sound to Clinton, a distance of 164 miles, has been over $61,000 per mile, or a total of something more than $10,000,000. The 44½ miles from Vancouver to the head of Howe Sound has been at the rate of $103,500 per mile, owing to expensive right of way in North Vancouver, and heavy rock excavation along the shores of English Bay and Howe Sound. The balance of the line, from Clinton to Fort George, has been of lighter construction, thereby reducing the average cost to $58,000 per mile.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

DOMINION LAND SURVEYORS.

The eighth annual meeting of the Dominion Land Surveyors was held in the Carnegie Library, Ottawa, March 3rd and 4th. Lectures of a scientific and practical nature were delivered by eminent members of the profession.

First Day.—Morning Session.—The President of the Association, Mr. C. F. Miles, D.L.S., was not present, as he is at present inspecting surveys in Northern Alberta. In his absence, Mr. J. J. McArthur, Assistant Commissioner of Boundary Surveys, acted as chairman.

A paper by H. G. Dixon, D.L.S., on the proposed transfer of natural resources to the western provinces provoked considerable discussion at the morning session. The western provinces having made a move to take over the management of their own natural resources, the Dominion Land Surveyors, in whose hands the work has always been, are afraid that they will lose some of their status—and, in fact, their jobs—if the provincial authorities achieve their desire. A committee was appointed to conserve the Association's interests in this matter.

Land surveying is apparently a healthy occupation. One member is 75 years of age and is still actively engaged in the rigorous duties even during the severe winter months. J. J. McArthur referred to this and pointed out what a healthy profession land surveying proved itself to be.

A paper on Arctic and Antarctic research was read by J. N. Brownlee, D.L.S., of Vancouver.

The report of Secretary-Treasurer Hubbell showed that the Association had made good progress during the year, and has a satisfactory financial balance. There are now 233 members. Motions of condolence were passed on the deaths of two of the members, J. K. McLean, D.L.S., and C. E. Johnston, D.L.S.

Afternoon Session.—A most interesting lecture, illustrated by photos and blackboard diagrams, mathematical formula, etc., was given on Tuesday afternoon. Dr. Otto Klotz, D.L.S., Chief Astronomer of the Dominion Observatory, was the speaker. The subject of the lecture was the "Seismograph" in its relation to earthquakes. While he did not deal with the causes of earthquakes, he expanded upon the results of phenomena. He mentioned an experiment which is being instituted at the Dominion Observatory to determine the physical tides of the earth, Ottawa has been selected, with three or four other points in the world, one in Germany and one in Africa, for the conduction of this experiment. A huge pit was now being dug in which the seismograph would be placed, and the experiments of the future continued. He fully explained the intricate and physical technique of the seismograph.

A useful paper on the transportation problem for survey work in the Canadian North was given by F. C. Herriott. This subject was considered of great importance, and two other papers bearing on this same subject, were read and discussed on the following day. Mr. Herriott gave many suggestions as to the best means of transportation for survey parties operating in the northern sections of Western Canada, many miles from civilization, which makes supplying the commisariat a most difficult problem. In summer there are canoe, and man-packs, while in winter months these give place to the dog-teams, or, in sections where the snow is not too deep, the pack-horse. Mr. C. F. Aylesworth, D.L.S., vice-president, occupied the chair.

Annual Banquet.—The annual banquet of the Association was held at Chateau Laurier in the evening. There were present the Minister of the Interior, Hon. Dr. Roche, Dr. Thompson, M.P., Yukon; M. McNutt, M.P., Saltcoats; H. S. Clements, M.P., Como-Atlin, B.C.; J. D. Taylor, M.P., New Westminster; Senator Casgrain, Dr. King, Director of the Dominion Observatory, and nearly a hundred Dominion land surveyors.

Among the speakers were Hon. Dr. Roche, Dr. Deville, Surveyor-General, and Senator Casgrain. The Senator is an old surveyor, by the way, and brought greetings from the Quebec Land Surveyors' Association. He was glad, he said, to have had some of his reward for his land surveying by his elevation to a body that went on for ever, and one that nothing could alter—the Canadian Senate.

Mr. George Mountain, Chief Engineer of the Railway Commission, told of his saving the Senator's life while in the wilds of Northern Quebec in a surveying party, sharing his small residue of food, when otherwise there would be no Senator Casgrain. Other interesting speeches were given during the evening by Dr. Otto Klotz, Messrs. Taylor, McNutt and Clements.

Second Day.—The attendance on Wednesday was even better than the first, a large number of the employees of the Topographical Surveys Branch, who are nearly all surveyors or assistants, were present, and the hall was again filled to overflowing.

The first paper was, "Goedetic Results and their Practical Meaning," by Mr. William Tobey, Dominion Topographical Surveyor. Another interesting paper was, "The Survey of River Lots in Manitoba," by Mr. Wm. Pearce, D.L.S. These papers elicited a lot of discussion by Mr. Thomas Shanks, Assistant Surveyor-General, Mr. A. E. Aylesworth, Mr. E. W. Hubbell Dr. Deville and others.

Several excellent papers were delivered later in the day. A paper on "Chaining," by Mr. A. H. Hawkins elicited much interest. Mr. Hawkins preferred the four-chain tape and the lighter tapes rather than the heavier. He impressed upon the surveyors present the vital importance of good chaining, and threw out many hints and suggestions for its further improvement. Several papers on "Pack Trains" had been prepared, two of which were read, one by Mr. J. M. Aitkens, D.L.S., and another by Mr. Hawkins. Transportation is one of the most important features of the surveyor's work, as he is often forced to work as much as 200 miles from railway and steamboat terminals depending on pack ponies, dog-trains, canoes and packers for the transport of the food supplies and paraphernalia. There was a lot of discussion. Messrs. J. E. Dodge, A. Milliken, Chas. Ways, Dr. Deville, E. W. Hubbell, Thomas Shanks, A. H. Hawkins, and others, participating. The laboratory for testing of chains and other surveying instruments, at Ottawa, in charge of the Topographical Surveys Branch, was described by Mr. Ways, Mr. Milliken described how the accuracy of azimuth and precise chaining was arrived at by calculation in the Topographical Surveys office.

Mr. Speight, O.L.S., brought greetings from the Ontario Land Surveyors' Association, and also described the work of base-line surveying in Northern Ontario.

The closing session in the evening was, by the kind invitation of Dr. King, held at the Royal Astronomical Observatory, when Mr. N. J. Ogilvie, D.L.S., delivered an address on "South Eastern Alaska Boundary." The surveyors had the privilege of bringing their lady friends to this meeting which they gladly accepted. All were cordially invited to inspect the instruments in use at the observatory. This was the most pleasant session of the series. The election of officers resulted as follows:—Honorary president, Dr. King; president, Mr. C. F. Aylesworth; vice-president, A. H. Hawkins, secretary-treasurer, E. W. Hubbell, Chief Inspector of Surveys, Ottawa. Executive committee: Messrs. D. H. Robertson, E. M. Dennis, A. H. Nelles, J. H. Wallace, and D. H. Dennis.

TORONTO BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The luncheon which the Toronto Branch of the Canadian Society held on Thursday, March 12th, was attended by over 100 members and friends. The chief speaker was Mr. Geo. G. Powell, Deputy City Engineer of Toronto, who gave a short address on "The Municipal Engineer," outlining the responsibilities associated with that official's work, his relation to the municipality as compared with the relation of the consulting engineer to his client, the difficulties to be surmounted in municipal service, etc. His address concluded with an optimistic plea to the young engineer, to investigate the possibilities that lie before him in the field of municipal engineering, claiming that it gives greater opportunity owing to the diversity of work within its scope, than does any other engineering field. The growing immensity of problems connected with water supply, pavements, railways and sewerage work and sewerage disposal, etc., were of such a nature as to demand a diligent search by municipal corporations for men with an up-to-date technical knowledge and experience that would qualify him as an expert in such work.

After the address had been tendered a hearty vote of thanks, the ensuing discussion involved the status of the student member among professional men in the Society, and it was generally felt that more recognition and greater opportunity for meeting those on a higher professional plane than he should be tendered him.

Mr. Hugh Lumsden, of the Transcontinental Railway, and Mr. A. L. Hertzberg, Division Engineer of the Canadian Pacific Railway, were the guests of the Branch. Prof. P. Gillespie occupied the chair in the absence of Mr. A. F. Stewart.

UNIVERSITY OF TORONTO ENGINEERING SOCIETY.

The University of Toronto Engineering Society held its annual elections on March 13th. The officers for the ensuing year are as follows:—President, E. D. Gray; Vice-President, F. T. MacPherson; Chairman of Civil Club, C. R. McCort; Chairman of Mining Club, J. M. Muir; Chairman of Mechanical and Electrical Club, K. O. Jefferson; Chairman of Architectural Club, T. Stewart Graham; Chairman of Chemical Club, J. E. Breithaupt; Fourth Year Representative, W. R. McCaffrey; Third Year Representative, J. H. Eastwood; Second Year Representative, Mr Honeywell; Treasurer, H. A. Babcock; Corresponding Secretary, R. W. Downie; Recording Secretary, T. W. McLelland; Curator, R. S. Bothwell.

The annual event had associated with it a change in the constitution of the Society whereby, for the better representation of the various branches of engineering followed at the university, the three sections; viz., electrical and mechanical, civil and architectural; chemical and mining are superseded by five clubs. This will facilitate the problem of a more suitable classification of the student membership of the Society in the presentation of technical papers.

MINING SECTION, CANADIAN SOCIETY OF CIVIL ENGINEERING.

The mining section of the Canadian Society of Civil Engineers met in Montreal on Thursday, March 12th. A paper of unusual interested entitled, "The Electrical Driving of Winding Engines and Rolling Mills," prepared by Mr. C. A. Ablett, A.M.I.C.E., and H. M. Lyons, A.M.I.E.E., was read by Mr. Ablett. The paper was an interesting description of numerous electrical installations at various mining and milling centres in different countries. It was illustrated by numerous lantern views showing Canadian, English and South African installations.

Mr. R. A. Ross, Vice-President of the Society, presided at the meeting.

THE AMERICAN PEAT SOCIETY.

It is announced that the American Peat Society will hold its 8th annual meeting at Duluth, Minn., on August 20th, 21st and 22nd, 1914. The address of the Secretary is 17 Battery Place, New York.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer. University of Pennsylvania, Philadelphia, P.A.

AMERICAN PEAT SOCIETY.—Eights Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

PERSONALS.

JAMES SHEPPARD, of Queenston, was recently appointed good roads superintendent of Welland County.

WARD CURLEE has been appointed City Engineer of Swift Current, Sask., to succeed Geo. D. Mackie, now of Moose Jaw. Mr. Curlee was previously assistant engineer to Mr. Mackie.

J. L. G. STUART, B.A.Sc., of the City of Toronto Roadways Department, is contemplating an extended trip through Europe for the purpose of studying transportation facilities of

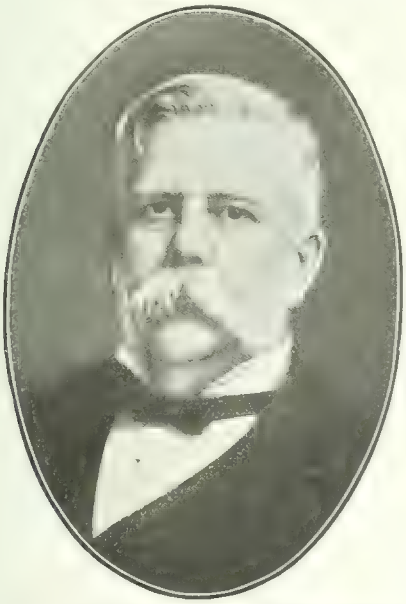
the principal cities and towns, and general municipal engineering practice. Mr. Stuart will leave about May 1st, going by way of the Mediterranean, and north through Greece and Hungary. Three months will be spent on the study of European municipal methods.

J. H. LARMONTH, who for some time has been engaged in private practice as a consulting engineer in Toronto, has been appointed superintendent of the Edmonton street railway, to succeed Mr. W. T. Woodroofe, resigned, on April 1st. Mr. Larmonth is a graduate of McGill University. He has had considerable previous experience in electric railway construction and operation, having had charge of the construction of, and later the management of, the Peterborough street railway. He was general manager of the Electric Power Company before opening an office as consulting engineer.

OBITUARY.

The death is announced of MR. GEORGE WESTINGHOUSE, engineer and inventor, who expired from heart disease at his New York residence on March 12th.

Mr. Westinghouse, whose inventions have for many years had a world-wide reputation and use, was himself the son of an inventor. He was born in 1864 in the State of New York. Before he was 15 he had invented and constructed a rotary engine, and at an early age he became an assistant engineer in the U.S.N. In 1865 he invented a device for replacing railway cars upon the track.



The Late Mr. Geo. Westinghouse.

The Westinghouse air brake, for which he is famous, is the product of a series of improvements upon what was first intended to be an automatic brake attached to the couplers. This was found unsatisfactory. The application of steam also proved unsuccessful, but was followed in 1869 by the use of compressed air and immediate success leading to manufacture. The many changes and improvements which have been made since that time have been practically all the result of Mr. Westinghouse's own investigation.

In 1880 his interest was directed toward the operation of railway signals and switches by compressed air, and the development and patenting of a system followed shortly.

In 1886 the company for the manufacture of electric lighting apparatus was organized, and in 1891 became the Westinghouse Electric and Manufacturing Company, which now employs over 22,000 people.

In connection with turbine development Mr. Westinghouse brought out the mechanical reduction gear for reducing the inherently high speed of a turbine to the slow speed of a ship propeller or d.c. generator. In other important phases of power development, such as alternating current transmission; use of natural gas; electric railway apparatus, etc., Mr. Westinghouse has played an important part. Owing to his many achievements he has been the recipient of numerous honorable distinctions, among which might be mentioned, the Scott medal of the Franklin Institute, the Edison gold medal, and the Grashof gold medal of the Society of German Engineers.

We regret to record the death of MR. ALEC. J. McMILLAN, of Victoria, B.C. Mr. McMillan, formerly a native of Pictou, N.S., has been engaged for a number of years in railway construction in Canada and the Western States. At the time of his death he was Chief Engineer of Construction for the British Columbia Mills and Timber Company, Vancouver, B.C.

The death is announced in England of MR. JOHN SCOTT, chief electrical engineer of the Commercial Cable Company, and one of the pioneer submarine telegraph engineers.

The death is announced at Boston, Mass., of MR. CHARLES MARSH CLAY, who for some time was engaged in Civil Engineering in Manitoba and the Canadian West. Mr. Clay was connected with early railroad construction in Western Canada.

PRIZES FOR HIGHWAY STUDY.

To encourage investigation of methods and materials for road and street construction and to interest engineering students in highway problems, the Barber Asphalt Paving Company has offered prizes of $100 for the best paper written by a member of the graduating classes of the leading engineering schools.

The title suggested is "Asphaltic Materials for Highway Construction." The paper and its conclusions may be based upon service tests and the lessons of experience; the physical qualities or chemistry of asphalt; or it may combine any two of these lines of investigation. The length of the paper is limited to 3,000 words and all manuscripts must be received not later than June 1, 1914.

The purpose of this prize offer is to turn the attention of engineering students to street and road construction as a field of work in which there is great need and great opportunity for trained men.

BACK COPIES WANTED.

Copies of July 21st, 1910, and November 3rd, 1910, issues of *The Canadian Engineer*, are required to complete a volume for binding. Any subscriber who has one or both of these copies for sale will please communicate with the Editor.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, is minus the following copies: July 21st, 1910; November 17th, 1910; May 11th, 1911; May 3rd, 1912, and August 1st, 1912, and would be glad to pay 25 cents per copy for any of them. Will subscribers who happen to have these copies, and who do not care to keep them, kindly send them to this office, and we will see to it that they are put into the hands of the party interested.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21442—March 4—Relieving, for the present, G.T.R. from providing further protection at Goodwillin's crossing, 1¾ miles west of Georgetown, Ontario.

21443—March 3—Directing that Kootenay and Alberta Ry. Co., grade west approach to bridge, in Sec. 7, Tp. 6, R. 1, W. 5 M., Alta., for a distance of about 300 ft., and extend guard rail for a distance of about 150 ft.; work to be completed by June 15th, 1914.

21444—March 4—Directing that, within 60 days from date of this Order C.P.R. install improved types of automatic bells at crossing of Kyle and Queen Sts., city of Port Moody, B.C., and thereafter maintain bells at own expense. 2. 20% of cost of installing each of bells be paid out of "The Rly. Grade Crossing Fund," and remainder be borne by Railway Company.

21445—March 4—Authorizing Municipality of Tp. of Nepean, at its own expense, to construct highway crossing over C.P.R. where same intersects Second Avenue, said Twp. of Nepean, County of Carleton, Ontario.

21446—March 5—Approving and authorizing clearance, as shown on C.P.R. plan, between Co.'s standard coal sheds and rail of its side tracks.

21447—March 6—Amending Order No. 17264, dated August 21st, 1912, by striking out word "South" before word "Half" where it occurs in recital and operative parts of Order, and substituting therefor word "East."

21448—March 6—Authorizing C.P.R. to construct Swift Current Northeasterly Branch Line across highway between Secs. 5 and 6-23-27, W. 3 M., Sask., at mileage 98.47.

21449—March 5—Approving revised location of C.P.R. Bassano Easterly Branch Line, from a point of its main line in Sec. 17-21-18, W. 4 M., at mileage 0.0, thence in an easterly direction to a point in Sec. 21-22-8, W. 4 M., Alta., at mileage 72.07.

21450—March 7—Authorizing G.T.R. to reconstruct bridge No. 49, mileage 123.75 from Black Rock, 20th Dist., over public road between Lots 5 and 6, Con. 1, Tp. Fullarton, Co. Perth, Ontario.

21451—March 6—Directing that the G.T.P. Ry. forthwith appoint a regular station agent at Cudworth Station, Sask.

21452—March 9—Authorizing Rural Municipality of Usborne, No. 310, Sask., to open up crossing over C.P.R. Pheasant Hills Branch at mileage 260.8, on East Boundary, S.E. ¼ Sec. 34-33-23, W. 2 M., Sask.

21453—March 9—Declaring that the land applied for (at Tappen, B.C., in Little Shuswap Indian Reserve, No. 5), is required by C.P.R. for railway purposes, and is land which, were it the property of a private owner, could be taken without consent of owner.

21454—March 9—Authorizing C.P.R. to reconstruct bridge 37.6 over Saugeen River, on Walkerton Subdivision, Ont. Division, Ont. And rescinding Order No. 20604, dated September 25th, 1912.

21455—March 9—Approving location C.P.R. station at Cadillac, in N.W. ¼ of Sec. 8-9-13, W. 3 M., Sask., on Co.'s Weyburn-Stirling Branch.

[illegible]456—March [illegible]—Authorizing G.T.R. to use and operate two (2) bridges—namely, No. 12, mileage 48.98, 30th Dist., P.Q., and No. 13, mileage 49.20, 30th Dist., Quebec.

21457—March 9—Authorizing C.P.R. to use and operate four (4) bridges—namely, No. 24.1, Eastern Div., St. Guil[illegible] Eastern Div., Newport Subdivision, No. 32.6, Eastern Div., Ottawa Subdivision, Ont., and No. 44.7, Eastern Div., Ottawa Subdivision, Ontario.

21458—March 9—Authorizing the C.P.R. to construct spur for T. W. Murray across gravel road and part lots 1, Con. 7, West of Yonge St., Twp. Vaughan, Ont.

21459—March 10—Approving location C.P.R. station at Shaunavon, Weyburn-Sterling Branch, Sask.

21460—March 9—Approving revised location of portion of Kootenay Central Ry. from mileage 91.85 to mileage 94.81, and authorizing applicant to cross with tracks of said line of railway Laurier St. and Borden St., in town-site of Athalmer, B.C.

21461—March 9—Directing C.P.R. forthwith to re-open station at Dunkirk, Sask., and re-appoint a station agent at that point.

21462—March 9—Relieving for the present the Pere Marquette R. from providing further protection at its crossing over public road just west of Renwick Station, Ont.

21463—March 10—Authorizing the V.V. and E. and Nav. Co. to construct a spur to the premises of the British Columbia Milk Condensing Co., Limited, at Guichon, B.C.

21464—March 9—Authorizing the C.P.R. to construct its Weyburn-Sterling Branch across highways between mileage 232.523 and 253.34 (23).

21465—March 10—Approving revision of grades and alignment between certain points on the Webbwood Subdivision and Algoma Subdivision of the Lake Superior Div. of the C.P.R.

21466—March 9—Ordering the C.P.R. within ninety days from date of this Order, to install improved type of automatic bell where its railway crosses the highway known as the White Lake Road, in the Village of Pakenham, Ont., and that all switching movements on the sidings be flagged over said crossing by a member of the train crew.

21467—March 11—Authorizing the Lake Erie and Northern Ry. to operate its trains, temporarily, for a period of ninety days from date of this Order, for the purpose of construction only, across the tracks of the Grand Valley Ry. Co. at station 372.60, near Paris, Ont.

21468—March 12—Amending Order 21345 by striking out the word "reconstruct" in the recital and operative parts of the said Order, and substituting therefor the word "construct."

21469—March 12—Approving locations of C.P.R. stations Notukeu and Pontiex on its line of railway in the Province of Saskatchewan.

21470—March 10—Extending the time within which to complete siding to and into the premises of Messrs. Whiteside and Arnold, on Lots 2 and 3, south of Tiffin St., in the town of Barrie, Ont., for a period of ninety days from date of this Order.

21471—March 12—Authorizing the G.T.R. to use and operate its trains over the bridge 168 across the Thames River, immediately west of London, Ont., at mileage 121.24 on the 17th Dist. of its line of railway.

21472—March 11—Authorizing the G.T.R. to use and operate the bridge carrying its line of railway across Elgin St., in city of Brantford, at mileage [illegible] on the 20th Dist. of its line of railway.

21473—March 12—Authorizing the G.T.R. to use and operate bridge No. 30, at mileage 83.60, 20th Dist., crossing River St., Paris, Ont.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

THE FIELD WORK OF THE LETHBRIDGE VIADUCT

With some Notes on the Construction of the Substructure

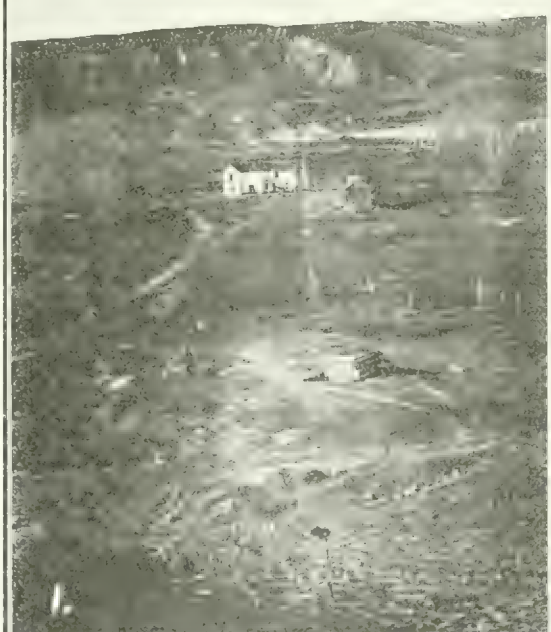
By B. RIPLEY, M. Can. Soc. C.E., M. Am. Soc. C.E.
Engineer of Grade Separation, Canadian Pacific Railway, Toronto.

IN the issue for September 17th, 1909, of *The Canadian Engineer* in an article entitled "Great Engineering Works on the Canadian Pacific Railway," the late J. E. Schwitzer, then Assistant Chief Engineer of C.P.R., western lines, dealt briefly on the construction of the Lethbridge viaduct and the spiral tunnels between Field and Hector. Subsequently, shortly after the opening of the Lethbridge viaduct for traffic, a most interesting and valuable paper was read before the Canadian Society of Civil Engineers by C. N. Monsarrat, Esq., a member of that society, now chairman of the Board of Engineers for the Quebec Bridge. This latter paper dealt chiefly with the design of the viaduct and its erection, touching briefly on the laying out of the substructure.

The author will endeavor to describe fully, the procedure adopted in connection with the laying out of the work, and the manner in which it was carried out in the field; also to describe some features of interest in connection with the construction of the foundations.

Up till 1894, the City of Lethbridge was the western terminus of a narrow gauge railway between that city and Dunmore Junction on the C.P.R. main line near Medicine Hat, then operated by the Alberta Railway and Coal Company, who, if the author remembers correctly, held the original charter for the building of the Crow's Nest Pass Railway. The Alberta Railway and Coal Company, also, before being taken over by the Canadian Pacific Railway, made extensive surveys to effect a crossing over the Belly River in the neighborhood of where the Lethbridge viaduct now stands.

The narrow gauge railway between Dunmore Jct. and Lethbridge was finally bought out by the C.P.R. and standardized, and the Crow's Nest Pass branch was built by them during 1897 and 1898, connecting Medicine Hat, on the main line, with Kootenay Landing, on the south end of Kootenay Lake. The Lethbridge-Macleod cut-off is a portion, approximately 31¾ mi. long, of the Crow's Nest Pass Branch of the Canadian Pacific Railway which was opened for traffic on November 1st, 1909.



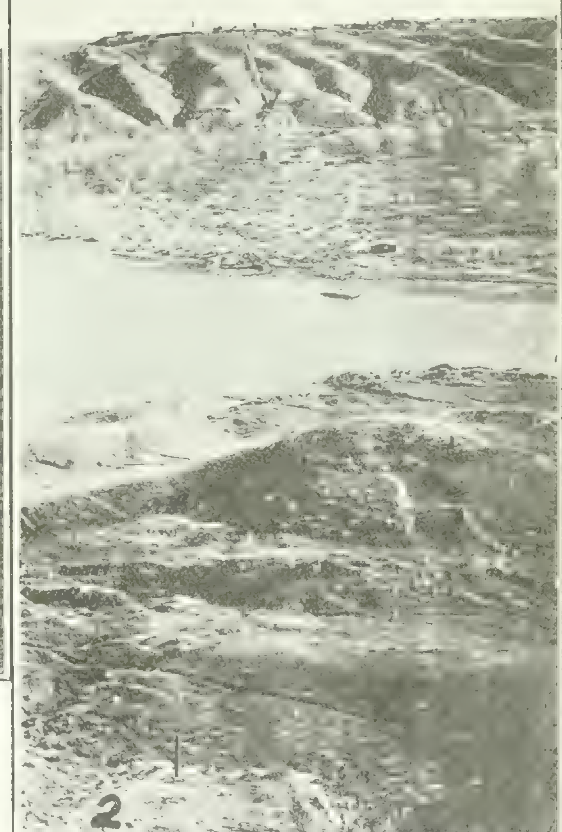
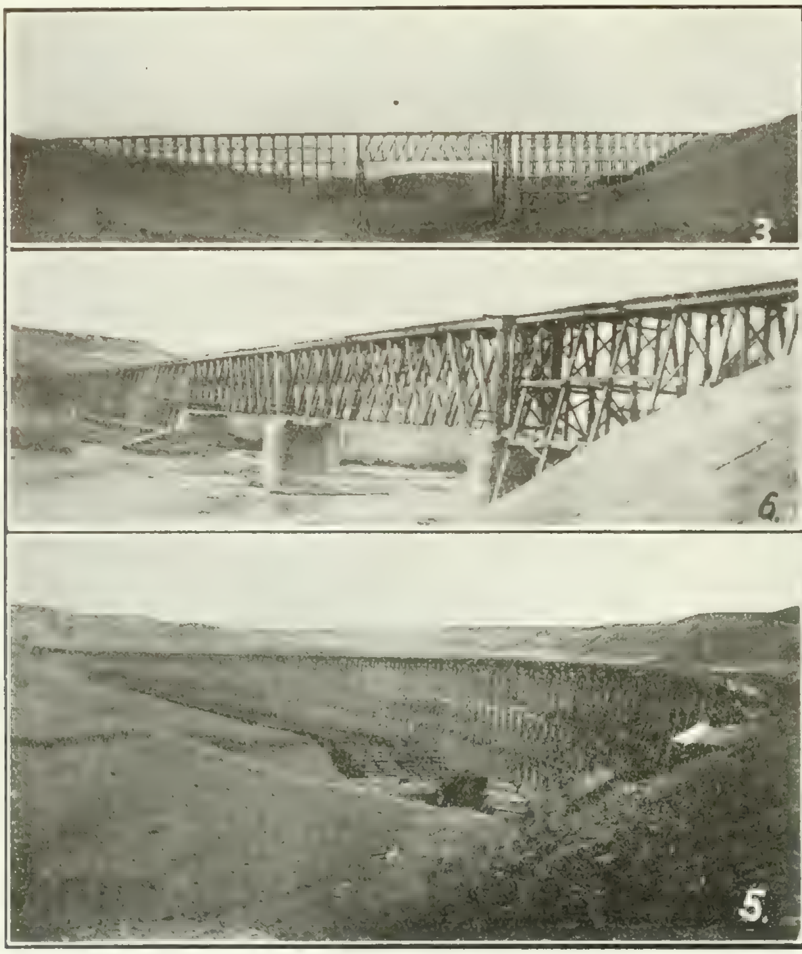


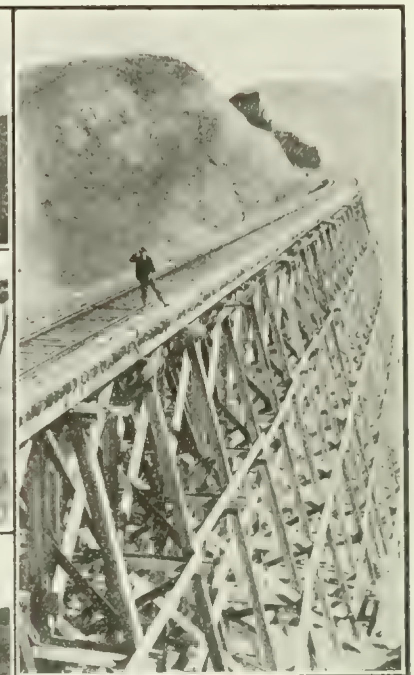
Fig. 1.—Site of the Viaduct Looking West.

Fig. 2.—Site Looking East.

The old line between Lethbridge and Macleod, which was built during 1897 and 1898, was approximately 37 mi. long and included, besides very heavy earthwork, the construction of some 20 trestles and bridges, containing approximately 15,000,000 ft. B.M. of timber. Only two streams were crossed, and these with low-level crossings,

but in getting down to the adopted level for these, it was necessary to build other 18 trestles and trestle bridges across the mouths of deep coulees or valleys, which were tributary to the main valley or gorge. Some idea of these coulees and of the main gorge can be had from in the majority of cases the problem of complete renewal was presenting itself. Contemplating the event of such a condition, the management of the company had extensive surveys made, covering several years, to determine whether any advantage could be had by the con-

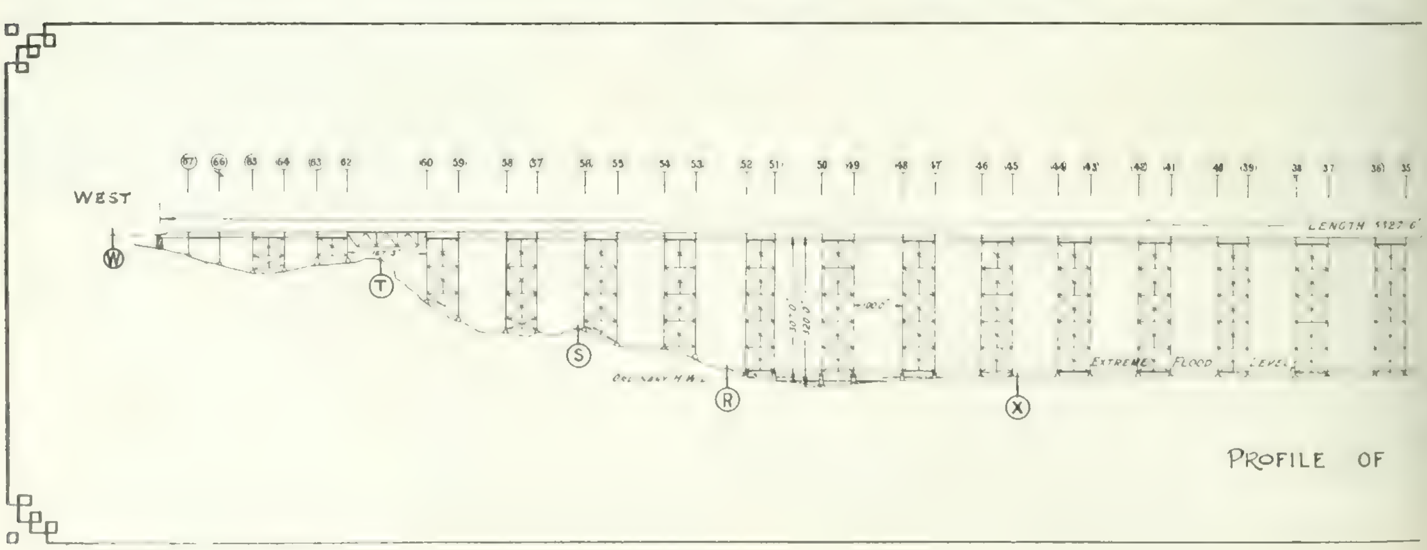




Figs. 3. and 4.—Trestles and Span Bridge over deep coulees. Figs. 5 and 6.—St. Mary's River Bridge, taken from west and east ends respectively. Piles 100 to 120 feet in length were used.

Figs. 1 and 2, and of the trestles and bridges which were built from Figs. 3, 4, 5 and 6, the two last mentioned showing the crossing of the St. Mary's River, about twelve miles above Lethbridge.

Operating expenses on the old line were very heavy. The life of a great many of the old structures had almost expired, making the maintenance of these excessive; and struction of any possible alternative line, and finally one located by F. M. Young, Esq., M.Can.Soc.C.E., now engineer in charge of construction on the Kootenay Central Railway, approximately 31¾ mi. long, with a gradient of 0.4 per cent., was chosen. On this line were two heavy high-level crossings—one over the Belly River at Lethbridge, and the other over the Old Man



River near Macleod. The first-mentioned crossing required a structure 5,327 ft. long and 300 ft. high, and it was decided to erect a steel viaduct with 67-ft. deck girder spans on towers and 100-ft. similar girders spanning the openings between the towers. The second of these two crossings was over the Old Man River near Macleod. This required a structure 1,890 ft. long and 150 ft. high, and it was decided to erect a steel viaduct with 45-ft. deck girder spans on towers and 60-ft. deck girders between the towers. Plate 7 shows a profile of the Lethbridge viaduct.

On the centre line, which was tangent throughout, permanent hubs were established at *W* and *F* (Plate 7), which were points near enough to the ends of the viaduct to be of value throughout the building of the bridge, but far enough from the structure that they would not be disturbed during construction. Holes, similar to post holes, were dug to a depth of between four and five feet,* and pieces of 8 x 8-in. timber were inserted in these, so that about two inches projected above the surface of the ground, which had been carefully levelled off. These were firmly tamped around with concrete, and after being centered, constituted the hubs from which the true centre line was established.

These were securely fenced, leaving a sufficient space within the enclosure to permit the setting up of a transit, and by a special arrangement, shown in Plate 8, a sighting rod was always left standing over the centre on these hubs, which was established on a small brass brad. These sighting arrangements saved considerable time, as otherwise it would have been necessary to have sent a picket man to the hubs every time they were used. As it was, the sighting rods were inspected from time to time to see that they were in true position, and were always carefully replaced after having been removed for a transit set-up.

After having carefully adjusted the transit, it was set up on *F*. Hubs *E*, *C* and *X* were established by using *W* as a foresight, then *T*, *S* and *R* were established from the west end of the line, using *F* as the foresight. Needless to say, all hubs were established in a manner similar to that of *W* and *F*, just described.

It will be noticed from the profile that in centering these points there would often be a great difference between elevations; and, in addition to having the lining hair of the transit truly vertical, and the standards carefully adjusted so that a vertical plane would be followed in depressing or elevating the telescope, double centering was used to further eliminate errors.

After having these main hubs or stations set up at the most commanding or useful points, Station *X* was chosen as the starting point for all measurements. There were several reasons for this. From *X* there was an excellent opportunity to get a sufficiently long base line for triangulation. More of the centre line could be seen from this than from any other point. At it, also, the triangulation base could be laid out at right angles to the centre line of the bridge, making it equally valuable for work in the direction of *W* as in the direction of *F*. The ground was fairly level, affording a good opportunity of measuring and checking the base line, and as it was of most importance to have the river work started first, Hub *X* would be close at hand and no delay would be had in laying out excavations for the river piers, the contractors for the substructure being already on the ground.

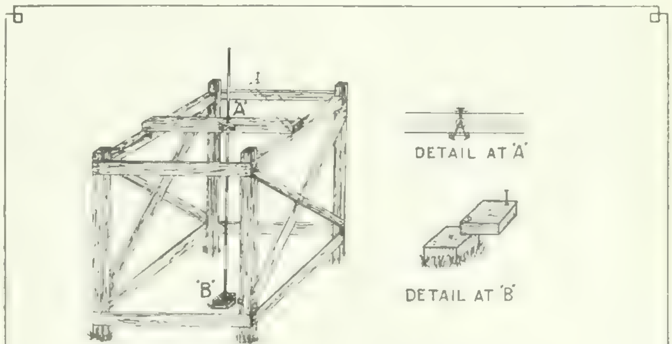


PLATE 8.

Although the centre line of the bridge had been measured both by the location engineer and the engineer making the preliminary survey from which the bridge was designed, no measurement across the gorge was made with sufficient accuracy for the construction of the foundations. It might be noted here that during the winter of 1906 and 1907, a special party was put into the field to make a preliminary survey of the site just referred to, and although extreme care was used, the final measurement, made with a steel tape, was slightly over three feet in error, as was found when the ultimate measurement was decided upon.

The banks of the gorge were very steep and irregular in places, and it was decided to start measurements in both directions from *X*, so that any error in the

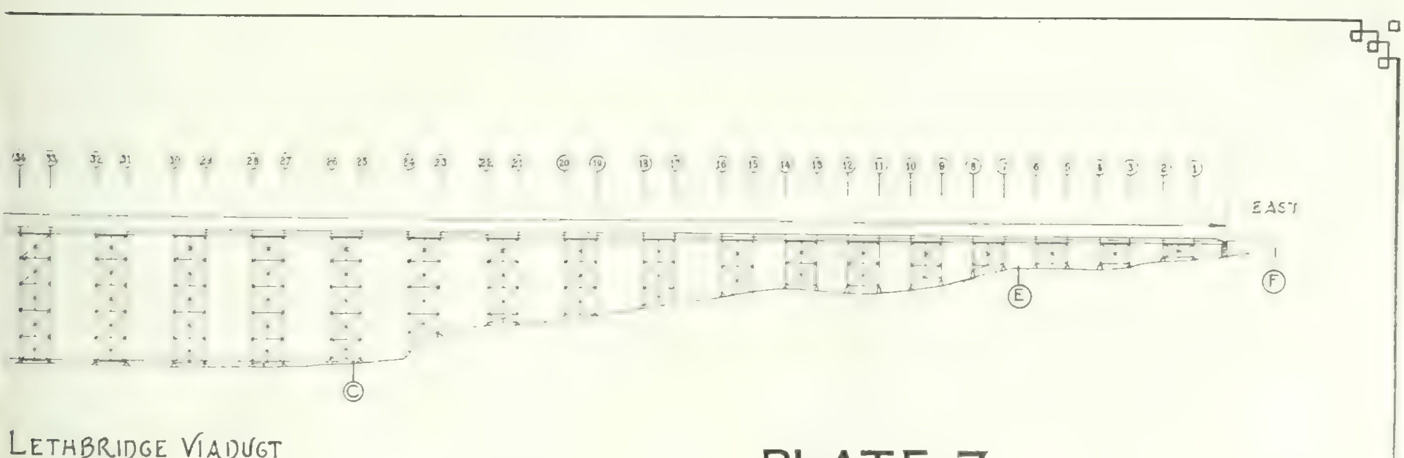


PLATE 7.

measurement of the centre line would be distributed on both banks, instead of being thrown upon one.

It might be mentioned that the actual work in connection with the laying out of the substructure was commenced during September, 1907, and at that time no detailed plans of the structure were available. Therefore, it was not safe to figure on any small errors in the total length of the viaduct being taken up by the erection of steel. It was therefore decided that nothing would be left undone in the matter of securing a correct chainage throughout the whole length of the bridge, and that nothing in the way of laying out of the different piers or bents should be done until this length was finally decided upon.

A method of measuring was then to be adopted. An unsupported steel tape was considered of little value on account of the prevalent high winds. (It should be mentioned here that the laying out of the work was commenced during a windy period which lasted till late the following April.) Neither was it considered advisable to use a supported tape for the reason that this method was not considered practicable. Therefore, on account of the wind and fluctuations in temperature, something less sensitive to both was required, and a graduated wooden rod was chosen.

A well-seasoned piece of cedar, 16 ft. long, 2 x 4-in. in section was obtained, and dressed to 1⅛ x 3 in. A supply of brass plates 2½ in. long, 1 in. wide and about 3/32 of an inch in thickness, bevelled on one long side, were made and set into the rod to receive graduations. About three inches from the end of the rod, the first one of these was placed so that the bevelled edge projected about 1/32 of an inch, and so that the surface of the plate was flush with the surface of the rod. See Plate 9 for details. This was marked with a very fine scratched line terminating at the bevelled edge, and designated zero. A plate was then put on at the 12-ft. mark, and from this point to the end of the rod, plates were put on at intervals so as to receive graduations at every tenth of a foot from the 12-ft. mark to the end of the rod.

A 100-ft. steel tape was procured, and compared with the standard of the company. Supported throughout its entire length at a temperature of 70 deg., with a 10-pd. pull, it was found to be 100.025 ft. in length. From this it was desired to establish a 90-ft. base from which to graduate the measuring rod for 15-ft. measurements. A suitable piece of ground was found, and a heavy 12 x 12-in. post about six feet long, was set into the ground about five feet, and so the top projected 12 in. above the ground, and a similar one was placed at the 90-ft. mark. Between these, other smaller stakes were firmly fixed, and on these 2 x 4-in. scantlings were nailed so that a straight line could be run on the level surface. The scantlings were left free from the 12 x 12-in. end posts so that any contraction or expansion caused by differences of humidity would not affect the main hubs on which the 90-ft. standard base was made. See Plate 10. A fine brass tack or brad, similar to those used by a shoemaker, was placed in the first post and a fine scratch made across its face. This was the zero of the standard 90-ft. base. The 90-ft. tack was set after having the tape stretched with the proper tension, calculation having been made for error in tape, also for difference of temperature, and marked as was the zero end by making a very fine scratch across the tack. Tacks were then lined in on the scantling edge that had previously been used to support the tape, and at 15-ft. intervals.

The 15-ft. mark was made very lightly on the proper plate on the measuring rod, as accurately as could be done with the steel tape. The measurement of the 90-ft. base was then attempted with the rod, and the 15-ft. graduation changed till six lengths of the rod exactly reached the 90-ft. mark on the standard base. When this was accomplished, the rod was considered correct at its 15-ft. length. The other graduations were put on by use of the common engineers' boxwood scale. The intention in measuring the length of the bridge was to place stakes at 15-ft. intervals, thereby using the 15-ft. graduation, as it was considered the more accurate of the graduations. Stakes were placed at other intervals from 12 feet to 15.5 feet only when it was impossible to place the regular 15-ft. stakes. The rod was also fitted with a reliable level bubble.

The measurement of X to C was then attempted, and the ground being fairly even and level, it was possible to measure horizontally, and without the use of a plumb-bob with one or two exceptions. Stakes were carefully lined in, stationed at 15-ft. centres, and levelled at the same time. After about five hundred feet of the

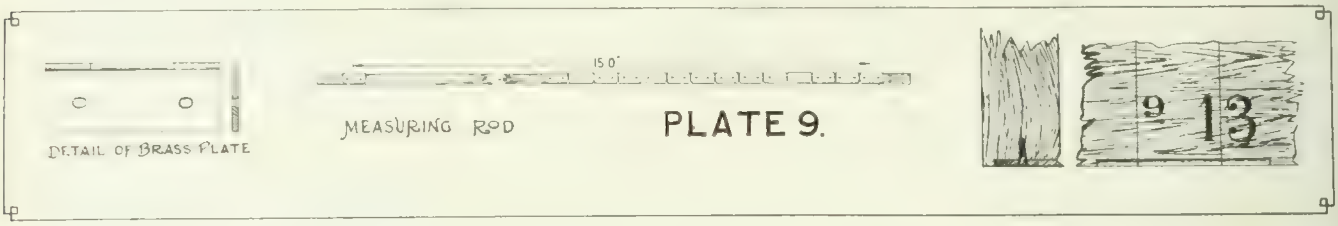


PLATE 9.

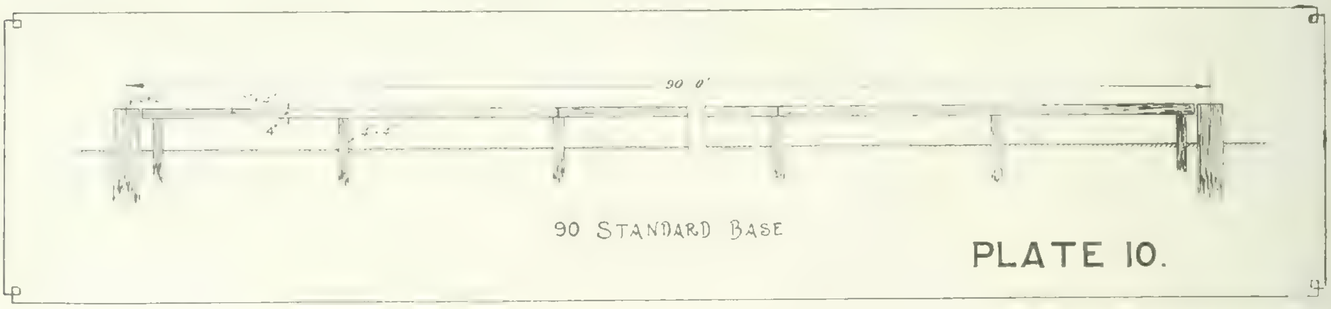


PLATE 10.

15-ft. stations were set, it was found necessary to start a new level of stakes about two feet lower than the first set, as the ground was found to be falling slightly in the direction of *C*. It was also found necessary, after this level of stations had been set for about six hundred feet, to raise the balance of the distance to a higher level. Measurement was carried from one level to another by using a fine plumb-bob protected by a canvas wind shield. See plumbing arrangement, Plate 11.

The method of measurement was as follows: Hub *X*, being the initial point, was set in concrete deeply planted in the ground as a safeguard against its being shifted, and a fine tack with a scratch across its face was made to indicate its chainage. The first set of level stations was measured after two transit points had been taken on the head of each stake, and these joined by a pencil line. This was in order that the transit need not be used while measuring was being done, so that the transitman could keep notes carefully and watch the work. With the zero end of the rod at the starting point, a tack was placed in the first station so that the 15-ft. distance would come upon its head, a fine scratch in the form of a sharp arrow was made on the tack with a small blade of a pocket knife, and this was checked to see that the 15-ft. graduation on the rod exactly coincided with the point of the arrow on the tack. To avoid confusion, no two marks were made on the same tack. The rod was then moved ahead to the second pair of stakes, and so on until a portion of the line was measured, but in no case was this distance too great to be checked three times the same day. Measurements were recorded by the transitman. The man at the zero end of the rod was then moved to the front end, the front end man being moved back to take the rear end, and the measurement checked carefully through. If any discrepancy was found, the recorder took one end of the rod and both rodmen jointly took the other end. When any differences were found, new tacks were used to receive the scratches. After a chainage was decided upon, the measuring rod was again checked into the standard 90-ft. base, and if found to be correct, the chainage previously agreed upon was allowed to stand.

After a final measurement had been agreed upon as far as hub *C*, a triangulation base was laid off south of, and at 90 degrees to the centre line from hub *X*, and this was carefully measured—759.270 feet in length, and from triangulation *X-C* was found to be 1639.115 as against 1639.110 measured with the measuring rod. See triangulation chart, Plate 12.

From *C* to *E* a great deal of steep and irregular ground was encountered, and on account of the small distance measured each time, and of the frequent uses of the plumb-bob as well as the winds, it was decided that no horizontal measurements should be taken. Some of the ground was as steep as 1 to 1½, and it would not have been practicable to have shielded the plumb line each time a measurement was taken. Slope measurements were taken in all cases, careful levels were taken over the stations and the horizontal measurements calculated. (See sample of notes, Fig. 13.) Wherever it was possible with some little grading to get two or more stations on the same slope, this was done. This simplified calculations, also reduced liability of error. On some slopes that were somewhat uniform, by a little grading it was possible to get as many as five or six stations on the same slope. The tops of these stakes were carefully lined in to the uniform slope by using a level and target rod. Wherever a change was made from one slope to another, the station where the change took place was called a "change," and this was written on the stake so that when levels were taken for the calculation of the horizontal measurements, the respective elevations of the changes only were required. The measured chainage of this portion of the bridge length was 1421.790 feet, as compared with 1421.805 feet which was computed from triangulation.

From *E* to *F*, the distance measured with the measuring rod was 547.834 feet, compared with 547.740 feet from triangulation. The west end of the work which was in the direction of *X-W*, was measured and triangulated in a similar way to the way in which the east end was done, the only difference being that point *W* was not visible from either *X* or *A*, and for this reason, a secondary base line had to be established by triangula

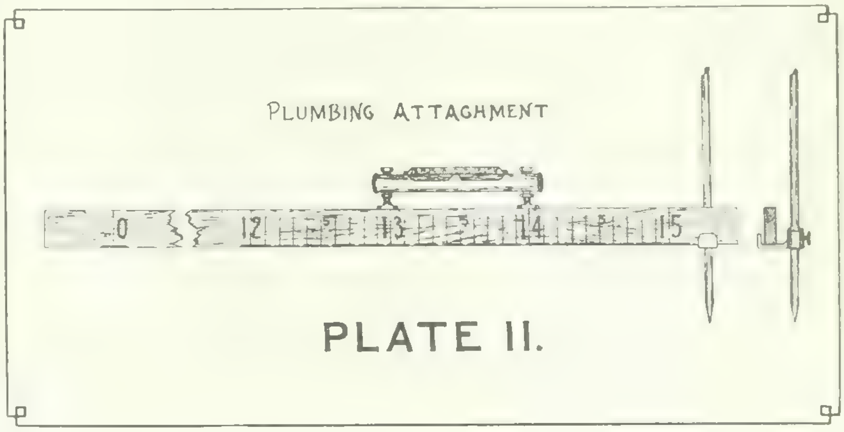


PLATE 11.

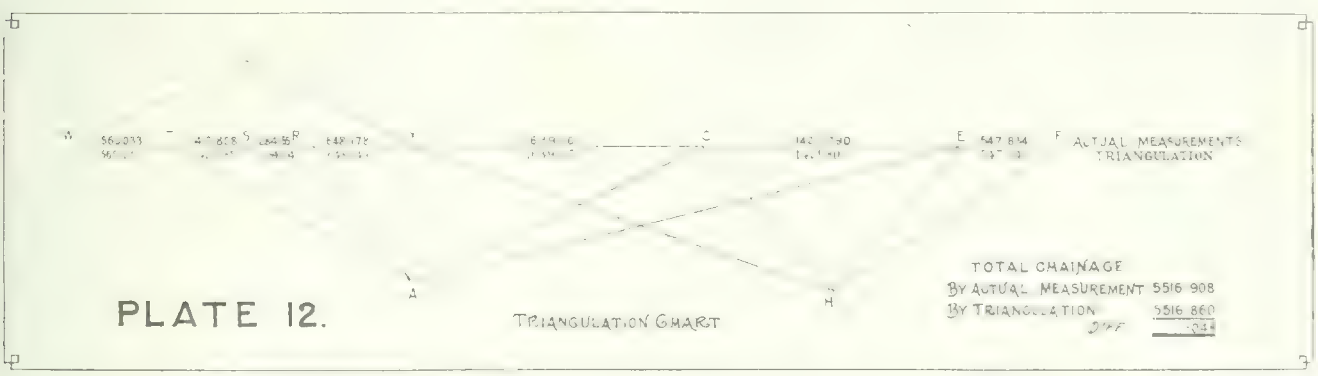


PLATE 12.

tion, and from this secondary base, the distance from T to W was had. The fact that W was not accessible from X will perhaps explain the discrepancy of .079 feet between the actual and triangulated distance between T and W, as a very slight error in the alignment of T which was accessible, would account for the difference.

Actual measurements were relied upon for the laying out of the work, and the triangulation was simply used as a means of detecting any large and appreciable errors that might possibly have come into the actual measurements, so small a measuring standard being used. Actual distance measured with the rod was 5516.908 feet, which compared favorably with the triangulated distance, which was 5516.860 feet, the difference being .048 foot, or about ½ an inch. The measuring of the centre line was considered the most difficult part of the work, and the actual measuring of the length of the bridge, slightly over a mile in length, took about six weeks of very trying time, especially on account of high winds.

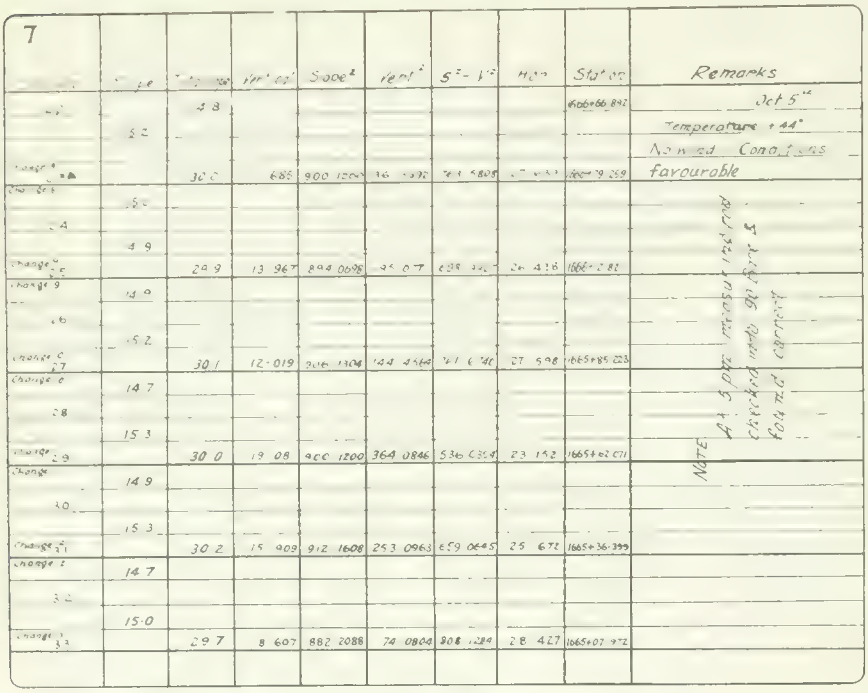


Fig. 13.—Sample Page from Field Book.

As it was necessary to proceed at once with the excavations, a great many of these were laid out immediately. The "bent" hubs were established by laying off the proper distances from the "change" stakes, the chainages of which had already been established as per notes in Fig. 13. Owing to the number of haulage roads that were to have been opened, and the number of sightseers constantly walking about, it was decided to have all bent hubs protected by a railing on four good posts set firmly into the ground, and enclosing a space sufficiently large to allow the setting up of a transit inside, and all intermediate stakes pulled out so as to avoid confusion, and to give the workmen, teams, etc., an opportunity of working without disturbing stakes. The preservation of permanent stakes and hubs was an important question on this work, and a great deal of pains was taken to protect them. The "bent" hubs were also referenced by means of other hubs set out at considerable distances, and approximately at right angles to the centre line. It will not be necessary to describe fully the actual laying out of the foundations, but it might be said that it was only necessary to turn off an angle of 90° 00″ from the centre line, and to measure out the given distance to the centre of the particular foundation. This was done by the tape on fairly level ground, but the measuring rod, and plumbing arrangement was used on irregular ground. This was generally done before the ground had been disturbed, and by setting up the transit over the centre of the foundations and turning off other angles of 90° 00″, four hubs were set that were sufficient for the contractors to carry out the work. When the ice was out of the river, the river piers were located by triangulation, which scarcely need be described. When it was possible to lay out piers from the ice, this was done in a similar way to that in which the land piers were laid out.

The initial bench mark was established from preliminary location bench marks, and inside the enclosure at hub X a hole similar to one which would have been dug for a telephone post, was made. Into this, a ⅝ inch steel rod was driven so that the top of it would be slightly below the original ground. Then concrete was dumped into the hole around the steel rod. The hole was then filled in with earth, and the bar carefully referenced, so that no unnecessary digging would have to be done in finding the rod. After the concrete had firmly set, the rod was examined to see that it had a well-defined top, on which a bench mark was established. Other bench marks were established at convenient points, from which, with one "turn," elevations could be given for the finishing of a pedestal near same. It was so arranged that it was never necessary to make more than one turn from any bench mark in setting elevations for the finishing of the tops of any of the pedestals.

In levelling to establish a system of benches, difficulty was had in the getting of fine calm days, and it was rarely possible to get two good days in succession. A Gurley level and sliding target rod were used. The levelman, after reading the rod, directed the rodman to set the target. This was then read again by the leveller, and if correct, both rodmen were instructed to read the target as a check on the leveller himself. As another precaution, after taking the final reading on the rod, the leveller was instructed to see that the bubble of the level was in the centre, and that in focusing, no jarring was done to the level. The level was always tested for adjustment every time before using, twice a day.

The levels were checked from one side of the gorge to the other several times, and although the writer is not in possession of the original notes at the present time, as far as he can remember, a check was had as close as .025 of one foot, which, considering the nature of the ground and the weather that was contended with, seems rather to have justified the care taken. The writer considers, for similar work, that a one-piece target rod is superior to the two-piece one that was used. With one of these there would be no danger of the slipping that has to be guarded against with the two-piece rod. Constant use also has a tendency to wear the mechanism of the two-piece rod, thereby making it less accurate for careful work. The sun being fairly dull at this time of the season, no sun shade was used. One precaution that was taken was that the leveling rod was, as far as possible,

kept in a place where the atmosphere was almost constant as to humidity.

Owing to the design of the steel work, it was necessary to have a precision of 1/8 inch in the finishing of the tops of the piers. Points were set for the forms, and after considerable concrete had been put in, points were set with fine nails for the finishing of the top of the pier.

The transit used was a Gurley light mountain transit that was used by the author on the harbor work of the G.T.P. at Prince Rupert, B.C., and afterwards remodelled to suit the conditions at Lethbridge. The horizontal limb and verniers were graduated to read to 20 seconds, and attached to the standards were special magnifiers for reading both limbs. These were attached to the standards by means of universal three-joint arms, allowing the lens to be placed over any point on either vernier. To further facilitate the determining of the angles required in triangulation, the process of "repetition" was used so as to distribute any inaccuracies of the graduations of the horizontal limbs, over several readings. After setting the vernier at zero, the telescope was sighted on the first point. The alidade was unclamped and swung over the necessary arc, and the telescope sighted carefully on the other point and the alidade clamped. Without reading the vernier, the limb was unclamped and the telescope carefully sighted on the first point and the limb clamped. The alidade was again unclamped and swung through the arc, and the telescope carefully sighted again on the second point and the alidade clamped. The vernier has now travelled twice over the arc, and the value of the angle is therefore one-half of the reading. This was done until the vernier indicated six times the actual value of the reading, and of course, this reading divided by six gave the value of the angles used in the computations. The angles were also read from both verniers, and in case of any difference, the mean was used. Errors due to angular distance between the verniers and to eccentricity of the graduated limb were largely eliminated by this method.

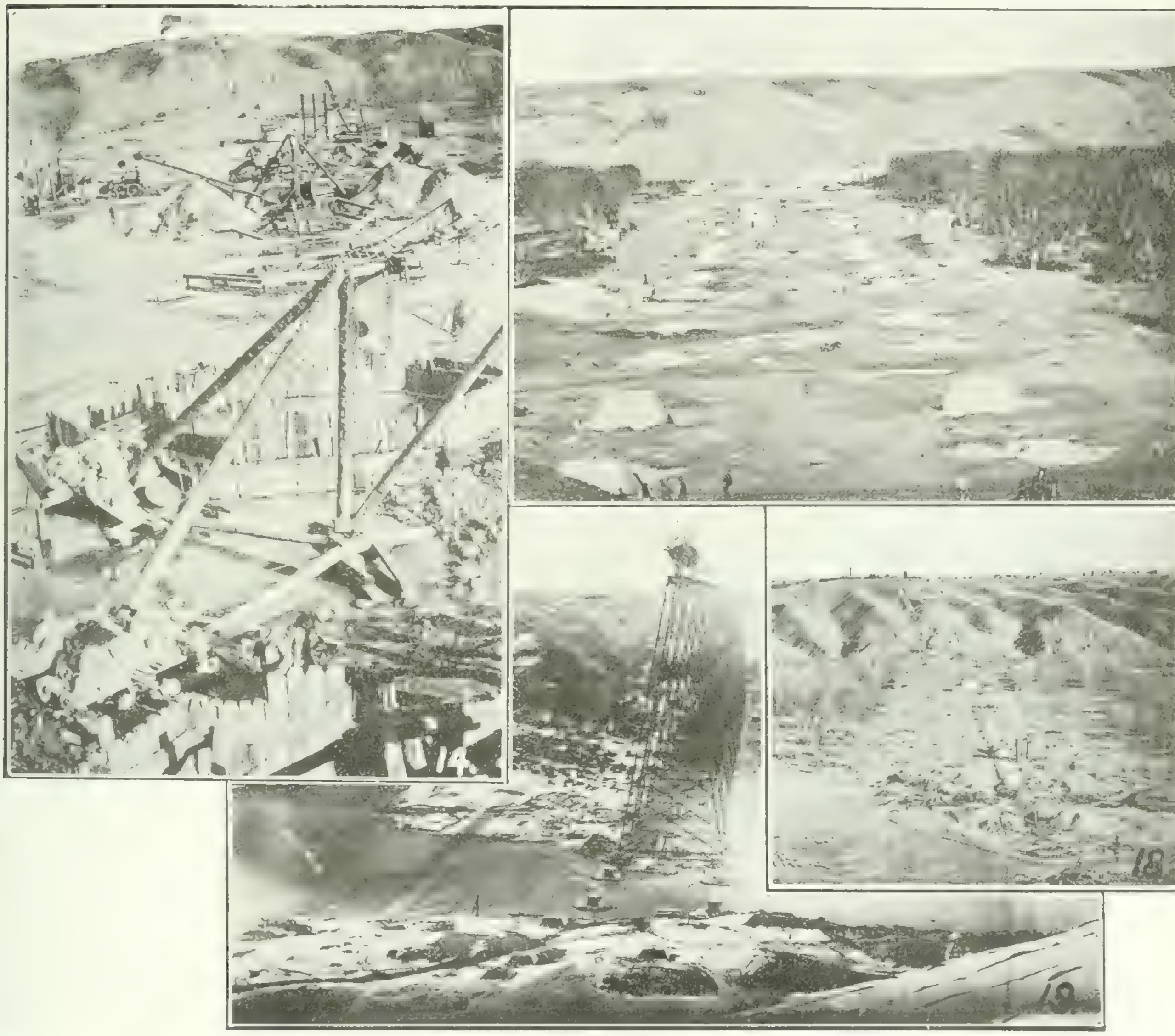


Fig. 14.—River work being carried on during winter of 1907-08. Fig. 15.—Pedestals complete on river bottom with work on west bank in progress. Fig. 18.—Looking eastward, showing sub-structure in progress. Fig. 19.—Erection of steel-work. Bent 47 just completed.

The plant used by the contractors for the substructure was as follows: 2 orange peel dredges, 1 clam shell dredge, 1 drag line dredge or excavator, 3 stiff leg

derricks, three 6-inch submerged centrifugal pumps, one 8-inch suction centrifugal pump, 3 traction engines, for steaming and driving pumps; 2 traction engines, to furnish steam for thawing out the bottoms of frozen excavations during the winter; 2 hoisting engines for handling concrete, 2 Raymond concrete pile drivers, 1 crusher with elevated bin, 2 Smith mixers, 1 Ransome mixer, and a great deal of smaller plant.

The first few feet of almost all of the land excavations were taken out by teams and scrapers, and the balance by pick and shovel. After this was done, the excavations were staked out, ready for piles, which were driven by the Raymond Concrete Pile Co. of Canada. It might be as well to describe briefly the Raymond concrete pile. A thin casing of sheet steel is made to fit a collapsible tapering core which is driven into the ground after it has received the sheet steel casing, by a heavy steam hammer. After the core with its casing has been driven to the required resistance, the core, which is made in three sections, and expanded by toggle joints before having received the casing, is collapsed and pulled out again. The casing remains in the ground, and concrete of a 1:2:4 mixture is poured into the casing, forming the concrete pile. These piles were chosen as the most suitable for the work, and gave excellent satisfaction.

bolted at the corners. The footings were filled neat to the ground wherever it was found possible to take out the excavation to the size required by the plans. On account of the formation it was rarely ever necessary to shore or timber any of the land excavations; the material invariably being stiff clay, and sometimes almost marl.

The river work, of course, was somewhat different. At the first pier, a clam shell dredge was set to work to clear off the gravel and sand from a bed of shale, which lay about 20 feet below the water, so that an open caisson when sunk would fit close to the surface of the shale. A solid 10-inch by 10-inch timber caisson was then sunk

Fig. 16.—River Piers as seen from Bent 52; cutting of west bank in progress. Height at top of the bank indicated. There is another bank not shown. Fig. 17.—Excavation for pedestals of Bent 61 in progress.

As soon as the piles were driven, any loose earth in the bottom of the excavations was taken out, and after the piles had set sufficiently, they were cut off with heavy cold chisels to allow one foot of the pile to remain in the footing of the piers. Forms were then put into place, and concrete operations commenced. The land piers being all of the same widths, and of various lengths, the forms were made so that they could be used over and over until worn out. In order that these could be readily moved about, they were made lighter than is usually the case. Good quality British Columbia flooring, ⅞ inch by 4-inch, was nailed to scantlings 2-inch by 6-inch, spaced at 18-inch centres. After the forms were placed in position, walings 6-inch by 8-inch, or 8-inch by 8-inch, were spaced around about the forms at sufficient intervals to keep the forms from bulging, and ½ inch iron tie rods were run through these and tightened up. After this, any loose scantlings or ribs were wedged so that all had a bearing on the walings. The walings were also

into place and weighted down with old rails. In making this caisson, caulking was done by tacking a strip of folded cotton to each layer of timber before putting on each successive layer of timber. Soundings with an iron rod showed up points at which the caisson was any considerable distance from the shale, and at these, light sheet piles were driven so as to scribe the shale, and in a way prevent leaks. Puddling was then done around about the bottom of the caisson, with gravel and clay. The caisson was then pumped out with two 6-inch pumps, and after making the necessary borings the footing was prepared for the placing of concrete. Before the placing of concrete was commenced, a trough was placed about one foot from the inner edge of the caisson, and caulked, and the pumping was confined to this area, so that nothing would be pumped out of the concrete.

On one or two of the other piers, another method was used. A skeleton was first made of successive rows of walings securely fastened together, conforming to the

shape of the pier to be built. These walings were placed at intervals to suit the pressure. The skeleton was then sunk into place and weighted down with steel rails. The walings referred to served a dual purpose; first as a guide to the sheet piling which was driven around them, and to receive the struts which were put in as pumping proceeded. Before any pumping was started, however, a second row of sheet piling was driven from four to five feet outside of the first row, and the intervening space was puddled.

Fig. 20.—Erection Traveller Placing the Last Girder.

From Fig. 14 a partly sunk skeleton is shown, and completed dams are shown on other parts of the work with both rows of piling driven, and one of the dams pumped out.

A third method was used where it was known to be impossible to pump out a cofferdam. Dredging was resorted to and continued until nothing further could be taken out by this method. An open caisson was then sunk into place, and as close to the shale as possible, and weighted down with old rails. Further preparation of the footing was made by divers. After a few feet of concrete had been placed in the bottom by bottom dumping buckets, the mass was allowed to set for a few days, and then pumping was resorted to. In the winter weather, steam was blown into the water near the bottom of the dam from boilers nearby, and this accelerated the setting up of the concrete. Little difficulty was found in pumping out any of the dams attempted in this manner, and after a dam was pumped out, it was a simple matter to place concrete.

The cement used was Buffalo Brand, made near Calgary, and the Exshaw Brand, made at Exshaw, Alberta. These cements were used and gave excellent satisfaction. One of the redeeming features of both brands was that they would set up fairly quickly, relieving to a great extent the pressure on the forms. When concrete was placed under water by means of bottom dumping buckets, a 1:2:4 mixture was used, and when water was not to be contended with, the concrete was of a 1:3:6 mixture.

A great deal of the gravel used came from the excavations along the river bottom proper, and was found with the proper proportion of sand, so that no screening was necessary. This proved to be very profitable for the contractors, and in one of the river piers, sufficient coal was taken from one of the excavations to feed the boilers furnishing steam for several river piers. Fig. 15 shows the pedestals at the bottom of the valley, also work proceeding on the west bank.

The large house in the centre of the picture was perhaps one of the first houses of any importance built in the North-west. It was built previous to the North-west Rebellion of 1885, and occupied by Mr. E. T. Galt, the first president of the North Western Coal and Navigation Co., which was later the Alberta Railway and Coal Co. This is the same house that is shown on Figs. 1 and 2.

Fig. 16 shows river piers for bent No. 52, with the grading of the west bank in progress.

Fig. 17 shows the excavation for foundations at piers No. 60. The necessity for the exceptional depth for these foundations was to get clear of some sliding ground indicated by cracks shown in the photograph.

Fig. 14 shows the river work in progress during the winter of 1907. A cofferdam is seen at the bottom of the picture, being pumped out. This is the excavation from which the coal was taken out. The next cofferdam above has been sheet piled, ready for pumping. Beyond this, two of the skeletons previously referred to are shown; one has been sunk into place, and the other is being sunk.

Fig. 18 shows the east bank at the Lethbridge end of the viaduct. The pedestals on the side hill are shown completed, and one row on the river bottom partly completed.

Fig. 21.—Cantilever Arm of Traveller. Note the erection cage suspended at the top of the tower.

The erection traveller has been so fully described in Mr. Monsarrat's paper, that nothing further can be said. Fig. 19, however, shows the traveller, which is also shown on Figs. 20 and 21.

This was certainly a very elaborate traveller, and so complete that the Canadian Bridge Company, who erected it, could have done nothing further to manufacture a machine for handling the steel, and provide safety for

their men. The working of the traveller need not be explained, but can be seen from Figs. 19, 20 and 21.

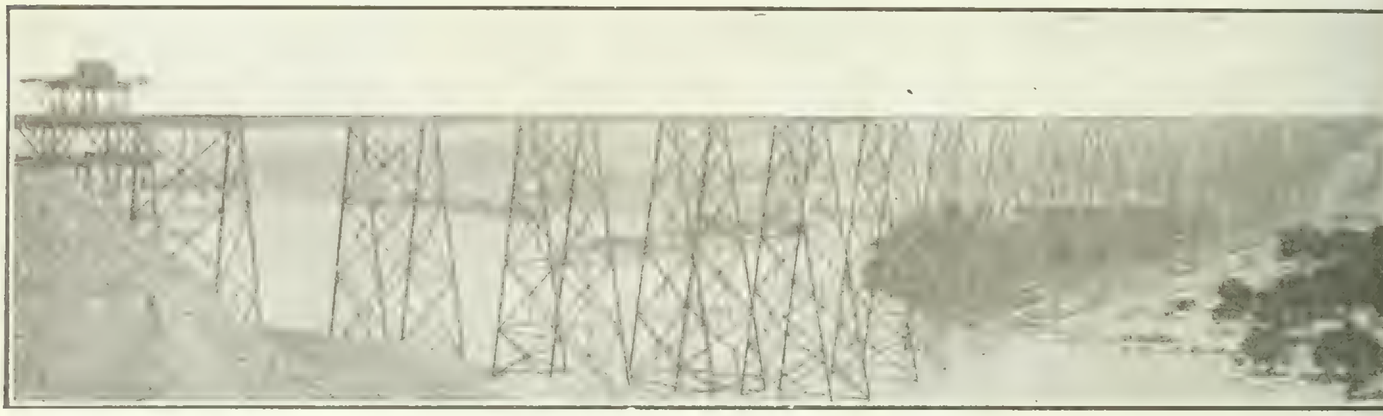
The whole work was carried out with very few accidents. One of the Canadian Bridge Company's workmen fell from the traveller, near bent No. 45 and, of course, was instantly killed, and two more men lost their lives by asphyxiation in a test hole that was sunk into the workings of an old coal mine on the east bank of the river.

The actual construction of the substructure started during September, 1907, and the bridge was opened for traffic on the 1st of November, 1909. Something like about 300 working days were required for the erection of the steel.

The bridge was designed by C. N. Monsarrat, Esq., M.Can.Soc.C.E., with Mr. C. C. Schneider, M.Can.Soc. C.E., consulting engineer. The work was handled from the office of the assistant chief engineer, Mr. J. E. Schwitzer, at Winnipeg, with Mr. F. St.C. Farran as engineer in charge of construction. The writer was assistant to Mr. Farran, and had immediate charge of the field work, in which he was ably assisted by Mr. A. F. MacDonald, now resident engineer of Bear River bridge, Dominion Atlantic Railway, and Mr. J. R. Middleton, resident engineer of Pitt River bridge, near Vancouver.

The contractors for the substructure were Messrs. John Gunn and Sons, of whom the writer cannot speak too highly in reference to the manner in which they carried out the work. This remark would apply to both the Canadian Bridge Company, who carried out the erection of the steel work, and the Raymond Concrete Pile Company, who drove the concrete piles.

Everything in connection with the work went along smoothly, and Fig. 20 shows the last girder being placed. The girder, of course, exactly reached the mark that had been set by the field party on the bridge seat of the west abutment, which was finished during the spring of 1908.



General View of Viaduct. The Riveting Traveller is seen over the Span between Bents 60 and 62.

PRODUCTION OF IRON IN CANADA IN 1913.

The iron ore shipments from Canadian mines during 1913 amounted to 307,634 short tons, valued at $629,843. These shipments included 92,386 tons of hematite and roasted siderite, 209,886 tons of magnetite and concentrates and 5,362 tons of titaniferous ore. The total ore shipments in 1912 were 215,883 short tons, valued at $523,315, and included 128,912 tons classed as magnetite and 86,971 as hematite.

Exports of iron ore from Canada during 1913 were recorded by the Customs Department as 126,124 tons, valued at $426,681. These were from Ontario, New Brunswick, Nova Scotia and Quebec. Imports, according to Customs records, in 1913 were 1,942,325 tons, valued at $3,877,824.

Shipments from the Wabana mines, Newfoundland, in 1913 by the two Canadian mines operating there were 1,605,920 short tons, of which 1,048,432 tons were shipped to Sydney and 557,488 tons to the United States and Europe.

The total production of pig iron in Canadian blast furnaces in 1913 was 1,128,967 tons of 2,000 pounds, valued at approximately $16,540,012 as compared with 1,014,587 tons, valued at $14,550,990, in 1912. Of the total production of 1913, 23,696 tons were made with charcoal as fuel and 1,105,271 tons with coke.

The classification of the production according to the purposes for which it was intended was as follows: Bessemer 265,685 tons, basic 614,845 tons, foundry and miscellaneous 248,437 tons. The amount of Canadian ore used during 1913 was 139,436 tons, imported ore 2,110,828 tons, mill cinder, etc., 33,583 tons.

The amount of coke used during the year was 1,417,148 tons, comprising 710,260 tons from Canadian coal and 706,888 tons of imported coke or coke made from imported coal. There were also used 2,206,191 bushels of charcoal. Limestone flux used amounted to 630,119 tons.

In connection with blast furnace operations there were employed 1,589 men and $1,149,345 were paid in wages.

The production of pig iron by provinces in 1912 and 1913 was as follows:—

	1912.			1913.		
	Tons.	Value. $	Value per Ton. $	Tons.	Value $	Value per Ton. $
Nova Scotia	424,994	6,374,910	15.00	480,068	7,201,020	15.00
Ontario	589,593	8,176,089	13.87	648,899	9,338,992	14.39

There was also a production in 1913 in electric furnaces of 8,075 tons of ferro alloys, valued at $493,018, compared with 7,834 tons, valued at $465,225, in 1912.

The exports of pig iron during the year are reported as 6,326 tons, valued at $351,646, an average of $55.58 per ton. Probably the greater part of this is ferro-phosphorous, produced at Buckingham, and ferro-silicon and ferro-manganese, produced at Welland.

There were imported during the year 253,843 tons of pig iron, valued at $3,234,877, charcoal pig iron 926 tons, valued at $12,528 and ferro-manganese, ferrosilicon, etc., 30,355 tons valued at $940,443.

ORGANIZATION AND METHODS OF STREET CLEANING DEPARTMENTS.*

By William H. Connell,
Chief, Bureau of Highways and Street Cleaning, Philadelphia.

(Continued from last issue.)

THE general methods of street cleaning in this country and abroad come under the following headings:—

1. Cleaning by gangs, consisting of 10 or 12 men equipped with hand brooms and the necessary appliances to clean the streets from curb to curb.

2. The blockman or patrol system in which each man is equipped with a bag or can carrier, a supply of cans or bags, broom, hand scraper or pan, sprinkler can, fire plug wrench, etc.

3. Cleaning with rotary machine brooms.

4. Flushing with squeegees which carry a tank through which water is sprinkled on the pavement and by the use of a rubber broom scraper cleanses the street.

5. Flushing with pressure flushers through which the water strikes the pavement under a pressure of 30 to 40 lbs.

6. Flushing with hose with the necessary pressure to thoroughly cleanse the pavements.

Methods of Cleaning.—In some of the larger cities in this country the method of doing this work during the past year was as follows:—

In New York the street cleaning force in the Borough of Manhattan, Bronx and Brooklyn, consisted of approximately 500 officers and 7,300 men. Each Borough was divided into districts supervised by a district superintendent and these districts sub-divided into sections supervised by section foremen. Manhattan had 13 districts and 60 sections; the Bronx 2 districts and 8 sections; Brooklyn 8 districts and 40 sections. The district superintendent covered his district in a buggy, and the section foremen used bicycles. Each district had a stable which was also the headquarters of the district superintendent, and each section had a section station, which was the office of the foreman, and where the equipment of the sweepers was stored. At 6.30 a.m. each day the sweepers, averaging about 2,875, assembled at the various section stations for roll call. They were uniformed in white suits and wore helmets in the summer time and caps in the winter. After roll call each sweeper, equipped with a can carrier and cans for the deposit of the sweepings, a scraper, broom and shovel proceeded to his designated route and covered the territory assigned to him. These routes varied in area from 5,384 square yards on the average in Manhattan, to 12,916 in Brooklyn. The sweeper first picked up the litter, then cleaned the gutters, and then swept from the centre of the street to the gutter. All the material gathered was placed in the cans, which were put on the sidewalk at the curb to await the arrival of the ash cart for their removal. In the purely business districts, as well as in the congested tenement districts, the work was done at night by cleaning gangs instead of blockmen. The method of machine broom cleaning, preceded by a sprinkling cart, was used as was also flushing by squeegees, pressure flushing machines and hose.

In New York City the ashes are collected daily except Sunday, one-horse metal carts with a capacity of 1½ cubic yards being used for the purpose.

Rubbish is called for when a sign is displayed in a window or other prominent place notifying the collector that rubbish is on the premises. The wagons used for this purpose are wooden carts with a capacity of 7½ cubic yards.

The department does not collect any trade waste or ashes from either office buildings or factories.

In the Borough of Manhattan the material is dumped on scows and transported to the low-lands where it is used for filling purposes. In the Borough of the Bronx, some of the material is dumped on scows and transported to the low-lands and in other cases it is hauled directly to meadows and vacant lots. In Brooklyn the material is transported by scows and also hauled by railroad to the low-lands and used for fill.

When the material is dumped on the scows it is heaped up and for transportation purposes it is necessary to trim the load so it will ride properly. During this trimming it is possible to reclaim a lot of saleable material such as paper, bottles, rubber, leather and miscellaneous junk. So valuable is this part of the work that the department sells the privilege and the contractor to whom the work is let furnishes all the labor free, and in addition pays an amount of money which brings the payment in labor and money up to approximately $300,000 per annum, according to E. H. Very, sanitary engineer, formerly of the New York Street Cleaning Department.

The garbage is collected daily except Sunday, one-horse metal carts of 1½ cubic yards capacity being used. It is loaded on scows and transported to a reduction plant at Barren Island, where it is put through the usual process of this method for the purpose of extracting the marketable products, such as grease, which is used for the manufacture of glycerine, cold creams, etc., and the tankage which is used for the filler in fertilizer.

Snow Removal.—In New York City snow is removed more extensively than in any other city in this country or probably in the world. The snow is hauled to the river front, vacant lots, etc., and the removal is paid for on the cubic yard basis.

All collections and street cleaning work in New York City are by municipal labor, the only contracts being those for the final disposal of rubbish, ashes and garbage.

City of Washington.—Street cleaning in the City of Washington is under the Street Department and is done by municipal labor. Only the blockmen are in uniform, wearing white suits and white canvas hats. The work is subdivided as follows:—

1. Hand patrol.
2. Machine broom cleaning.
3. Squeegeeing.
4. Flushing.
5. Alley cleaning.
6. Suburban cleaning.

The hand patrol or blockmen area covers approximately 2,750,000 square yards or 55% of the area of the city, and includes the entire business section, the downtown residential section and a great deal of the better class of residential suburbs. The entire area is cleaned daily by blockmen, and 219 men are employed for this purpose. In addition, a large portion of it is either squeegeed or flushed about twice each week. This area is divided into six sections, each section having a foreman, 2 or 3 wagons, and from 19 to 49 men, the areas ranging from 308,000 to 523,000 square yards. Each

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*Lecture delivered by Mr. William H. Connell before the Graduate Students in Highway Engineering at Columbia University on January 15th, 1914.

foreman is given absolute control over the forces under him and is directly responsible to the superintendent for the condition of the streets in his section.

The equipment used in hand patrol work consists of hand machines, bag carriers, burlap sacks, push brooms, hand scrapers, sprinkling cans and shovels. The dirt collected is placed in sacks and left at convenient points to be collected by special wagons and taken to the dump in sacks, these being returned by the drivers. Sacks are used in preference to cans because of the weight, bulk and noisiness of the latter.

After all the hard material has been removed from the streets by the blockmen, a hand machine broom is used, which picks up all the fine dust and loose droppings. In other words, the machine broom is used to polish the street and if properly used does away with the necessity for using horse-drawn machine brooms.

Machine Broom Cleaning.—The area swept with machine brooms consists of 2,220,000 square yards, or 45% of the paved area of the city, being almost entirely residential and each street being swept every other day. The force employed consists of 4 gangs, each composed of 1 sprinkler, 3 machines, 4 carts, and from 4 to 7 broomers, depending upon the conditions in the particular sections.

Streets are always swept from the centre toward the curb, the machines following one another and overlapping slightly. If the street is too broad to be swept solid in one operation, the machines turn in rotation, each taking a block, as may be required.

Squeegee Cleaning.—The area included in squeegee cleaning comprises a large portion of the smoothly paved streets in the white wing or patrol sections, amounting to about 1,786,000 square yards or 64% of the total white wing area. At the present time the method of operation is 1 sprinkler, followed by 3 machines. The sprinkler precedes the squeegees some slight distance, which allows the baked dirt to be softened by absorption, the sprinkler throwing as much water as possible without flooding the pavement. The squeegees brush the dirt to the curb, after which it is swept into piles by the white wings and hauled away.

Street Flushing.—Flushing machines are used on poorly paved streets and block pavements in the white wing area, each street being flushed about twice weekly by a high-pressure flushing machine.

Alley Cleaning.—The majority of the alleys in Washington are wide enough to be cleaned by a one-horse street sweeping machine, cleaning a 5-foot swath. Alleys are cleaned about once each week. Alleys too narrow to permit of the use of machine brooms are cleaned by hand gangs, usually consisting of a foreman and 6 men. These alleys are cleaned once per week and at stated periods are flushed with a hose.

Suburban Cleaning.—The cleaning of the suburban streets consists in keeping the gutters clear, removing all trash, loose stones and leaves.

Collection and Disposal of Ashes, Rubbish and Garbage.—The collection and disposal of ashes, rubbish and garbage in the City of Washington is done by contract. The ashes are collected semi-weekly between November 1st and April 15th, and weekly during the rest of the year, within the thickly populated districts; the remainder of the city receives weekly collections from residences, boarding houses, apartment houses containing not more than 4 families, etc. Two-horse wooden wagons of about 4 cubic yards capacity, with canvas covers, are provided for this purpose. All ashes are hauled to the authorized dumps, mostly low-lands.

Waste is collected weekly throughout the city. Single horse wagons with latticed sides, holding about 7½ cubic yards, are used for the collections. The waste is hauled to the reclamation station maintained by the contractor, where the saleable products are sorted and the balance incinerated. The paper is sorted and baled; bottles separated and crated; the other materials reclaimed are leather, rubber, tin cans and metal scraps.

Garbage is collected daily except Sundays between May 15th and October 16th, in all sections of the city within the thickly populated districts. Between October 15th and May 15th, the garbage is collected but three times a week. Outside the thickly populated sections, collections are made three times each week, both winter and summer. Hotels, hospitals, market houses, etc., are given daily service, including Sundays, throughout the year. The wagons used are one-horse metal-bodied wagons, water-tight, and with a capacity of approximately 1½ cubic yards. Garbage is disposed of by the reduction method.

Philadelphia.—Street cleaning in the City of Philadelphia is done under annual contracts, the city being divided into 8 districts and the work in under the supervision of the district engineers of the Highway Bureau and their corps of inspectors.

The specifications provide for the removal of ashes, waste and rubbish at least once each week from all buildings, and for the cleaning of all streets 6 ft. 6 in. in width or over, either by machine brooms, squeegees or flushers, in accordance with the schedule. All equipment to be operated in accordance with a schedule which specifies the streets in the order in which they are to be cleaned with the various types of equipment. Squeegee machines, high-pressure flushing machines and sprinklers are not used when the temperature conditions are such as to make their use undesirable, due to causing slippery streets in freezing weather. During the winter when this work cannot be done, additional machine brooms and gangmen must be provided to clean the streets with the frequency called for.

The total amount of yardage cleaned every day is 1,354,364 yds.; cleaned every two days, 9,898,918 yds.; cleaned every three days, 5,380,711 yds.; and cleaned once per week, 425,552 yds.; which makes an average cleaned per day of 8,134,987 yds. The total yardage of streets to be cleaned in this manner is 17,059,545. In addition to this the specifications provide for the cleaning of all alleys from one to six times per week, depending upon the necessity. There are approximately 12,000 alleys in the city under 6 ft. 6 in. in width.

The specifications also stipulate that the contractor must furnish a certain number of blockmen for each district, fully equipped with the necessary bags and bag carriers, scrapers, brooms, sprinklers, etc. The number of blockmen ranges from 57 to 140 per district. A certain number of hand machine brooms, squeegees, and flushers are also specified for each street cleaning district.

All blockmen and gangmen wear white uniforms with white helmet in the summer months and white caps in the winter months. All drivers and helpers wear khaki uniforms with khaki canvas hats in the summer and caps in the winter. Superintendents and foremen wear dark gray uniforms and caps. Inlet gangs are uniformed in khaki with hats in the summer and caps in the winter.

The following is a description of the methods of handling this work, which is divided as follows:—

1. Hand patrol.
2. Machine broom cleaning.
3. Squeegeeing.
4. Flushing.
5. Alley cleaning.

Hand Patrol.—The blockmen are assigned to sections designated by the chief of the Bureau of Highways and Street Cleaning, the area to be covered depending upon the character and amount of traffic. The duties of the blockmen consist of patrolling these areas, gathering all paper or other refuse, and sweeping street dirt as fast as it accumulates and placing it in dust-proof bags or metal cans, after which these bags or cans are collected and loaded into special wagons and hauled to a collection station or dump.

The equipment used in the hand patrol work consists of hand machines, bag carriers, burlap sacks, push brooms, pan scrapers, sprinkling cans and shovels. The dirt collected is placed in sacks and left at convenient points to be collected by special wagons and taken to the dump in sacks, these being returned by the drivers. Sacks are used in preference to cans because of the weight, bulk and noisiness of the latter.

Machine Broom Cleaning.—All machine broom cleaning is done in batteries of two or three, preceded by sprinklers, the number of brooms in each battery depending upon the width and character of the streets to be cleaned, the average gang consisting of two machine brooms, one sprinkler, four to seven broomers, and a sufficient supply of carts or wagons to remove the sweepings, the number depending upon the haul to the dumps and the season of the year, together with the amount and character of traffic.

Squeegee Cleaning.—Squeegee cleaning is used on smooth pavements. The operation consists of batteries of two and three squeegee machines preceded by sprinklers to soften and loosen the material on the streets, the sprinklers using as much water as possible without flooding the pavement; the squeegees using just enough water to create a wash. The idea of sprinkling is to soften the surface and enable the squeegees to cleanse the streets of all slime as well as the coarser materials. The squeegees are followed by two men, who immediately sweep up the winddrows of dirt into piles, and a sufficient number of carts follow to remove the dirt from the streets.

Flushing.—Flushing machines are used only on the poorly paved streets and block pavements. The high-pressure flushing machines are usually operated singly, as most of the districts have but one flusher.

Alley Cleaning.—All alleys and streets whose width between curbs is too narrow to permit the use of machine brooms, are cleaned once each week with a hose. When such streets or alleys are required by schedule to be cleaned more than once a week, the additional cleaning is done by hand brooms.

All inlets on paved streets and alleys are cleaned as often as necessary to keep them at all times free from obstructions, this work being done by special inlet gangs consisting of three men and a sufficient number of carts.

Collection of Ashes.—The collection of ashes in the City of Philadelphia is done by contract, as is also the collection of rubbish and garbage.

Ashes from household fires are removed once each week from all buildings, two-horse wooden wagons of about 4 cu. yds. capacity being used for this purpose, and provided with canvas covers. All ashes are hauled to authorized dumps, mostly low-lands and streets requiring filling.

Waste is collected weekly throughout the entire city when a card is displayed in the window or some conspicuous place notifying the contractor that waste is on the premises. Two-horse wagons with latticed sides, holding 7½ cu. yds., are used for this purpose. The waste is hauled to dumps.

Collection of Garbage.—Collections are made daily, except Sunday, in all sections of the city, from residences. Garbage from retail groceries and fish dealers is collected daily in quantities not exceeding one bushel from each store or stand. Dead animals are also removed by the garbage contractor. The wagons used for the collection of garbage are one- and two-horse metal-bodied wagons, water-tight, and of a capacity of 1½ to 2½ cu. yds. The garbage is hauled to the plant of the contractor and disposed of by the reduction method.

Snow Removal.—The street cleaning specifications also provide, in case of snow, for the entire force of the contractor not engaged in the collection of ashes and rubbish, to be used in removing the snow, when and where directed. In order to remove the snow quickly from the central and business portion of the city, separate contracts are also entered into, in which removal of snow is paid for on the cubic yard basis and in most cases it is dumped into sewer manholes at convenient locations or in the rivers.

The following is a description of the equipment used in street cleaning work in Philadelphia:—

Hand Machine Broom.—A revolving broom encased in a sheet iron box, so constructed as to receive the materials swept up by the machine. The broom is approximately three feet in length.

Squeegee Machines.—These consist of a tank for water with a capacity of 500 gallons, a cleaning roller set obliquely, geared or chain-belted to the rear axle, having a steel axis and rubber spiral fins.

High-Pressure Flushing Machines.—A machine having a tank for water with a capacity of 500 to 700 gallons, with a gasoline pump by which the water is discharged from the nozzles, with a pressure of at least 35 pounds per square inch. The nozzles are elongated and so constructed that their direction may be readily changed and adjusted as required.

Machine Brooms.—Machine brooms consist of a roller set obliquely and geared or chain-belted to the rear axle, the roller having a wooden axis and split bamboo bristles, whose length when new shall not exceed fourteen inches from the axis. These machines are provided with dust and mud guards.

Sprinkling Machines.—Consist of a tank for water with a capacity of 500 to 700 gallons, with adjustable valves, the water being delivered by gravity pressure.

There are other appliances, such as mechanical pick-up sweepers, which, however, are not in general use. The methods of cleaning and the equipment in use today are more or less crude and capable of very great improvement, and there is ample opportunity for engineers to show their ingenuity and initiative in devising improvements over the present methods used in this country and abroad, as street cleaning is still in the experimental stage.

The following comparison closely approximates the cost of street cleaning, collection of ashes, rubbish and garbage in Philadelphia, New York and Chicago for the year 1912:—

	Area, sq. miles.	Area, sq. yds. pavements.	Population.	Total cost.	Cost per capita.
Philadelphia	129.5	17,080,545	1,610,000	$1,812,310	$1,125
New York	....134.1	26,454,553	4,743,771	8,[illegible],845	1,[illegible]4
Chicago	....191.5	18,618,155	2,307,638	2,795,077	1,211

It is very important that street cleaning work should be effective, but it should be carried on efficiently and economically as well. We must not lose sight of the fact that this work, as well as any other branch of municipal work can be overdone as well as underdone. The methods, cost, and character of cleaning in the different cities vary so much at the present time that it would appear to be desirable to carry on a country-wide investigation, with a view to determining upon more or less standard methods and degrees of cleanliness for the different characters of streets and types of pavement. The cost, in each case, would always vary with the kind and amount of traffic and labor conditions in different localities, and in making comparisons these allowances should be made. This investigation should also go into the question of the collection and disposal of garbage, ashes and rubbish, taking into consideration the proper number of collections to insure carrying on the work not only in a sanitary but an efficient and economical manner.

The following schedules of collections in some of the municipalities indicate that there is considerable diversity of opinion at the present time as to the frequency with which collections should be made:—

	Ashes.	Rubbish.	Garbage.
New York	Daily	Daily	Daily
Philadelphia	Weekly	Weekly	Daily
Chicago	3 times per week		
Washington	Weekly and semi-weekly		
Boston	3 times per week		

A great many of the methods in our cities in connection with the disposal of ashes, garbage and refuse are both crude and unsanitary, and show the lack of scientific research in connection with these matters. The present status of street cleaning work, including the collection of ashes, garbage and rubbish throughout this country is not entirely due, as has often been stated, to the newness of the problem, but to the fact that the work has been more generally under the control of men who have not had any particular qualifications for the job, and have not been in office a sufficient length of time to familiarize themselves with the work, or carry on constructive studies with a view to improving conditions. If the work is put more generally under permanent engineering organizations, much greater advance will be made within the next twenty years than has been in the past twenty years. This was illustrated by the complete change in personnel, methods and character of work inaugurated in the New York Street Cleaning Department by Col. Waring, who might well be termed "the Father of Modern Street Cleaning Methods in this Country."

Sir William Willcocks, supervising engineer of the Assouan dam, has chosen Hugh L. Cooper, the engineer who constructed the Keokuk power dam across the Mississippi, as a consulting engineer for the Egyptian Government in the construction of a new hydro-electric dam across the Nile. Mr. Cooper has specialized in the direction of long dams of small heads; and this is the problem of the engineers who are seeking to control the waters of the Nile.

THE RELATION BETWEEN THE MELTING POINT AND THE VISCOSITY OF REFINED TARS.*

By Philip P. Sharples,
Chief Chemist, Barrett Manufacturing Company,
Boston, Mass.

THE rough dependence of the viscosity of refined tars, as determined by any of the standard instruments and their melting point, has been long recognized. Many discrepancies have, however, been noted, and apparently little thought has been given to the relation between the two in making specifications.

Table I. shows a series of samples taken from refined tars made on a manufacturing scale from the same raw tars. The methods used in analysis are those described by S. R. Church in the Journal of Industrial and Engineering Chemistry, Vol. 3, No. 4, April, 1911, and Vol. 5, No. 3, March, 1913.

The melting point is the half-inch cube method in water, starting, however, at 40 deg. F. instead of 60 deg. F.

The Schutte penetrometer is, strictly speaking, not a penetrometer, but a modified melting point. An arbitrary melting point is assigned, and the time taken at the assumed melting point to force out under constant pressure a plug of the material cooled to 40 deg. F. is noted. The arbitrary melting point is so chosen on a 10 deg. F. scale that the number of seconds is as near as possible 100 deg.

The float test is the New York Testing Laboratory test. The plug was cooled to 41 deg. F. before floating. The Engler test is made under standard conditions with the exception that 100 c.c. were run off instead of 200 c.c. The reduction of the number of cubic centimeters with viscous materials allows more concordant results to be obtained and gives lower figures.

A comparison of the three melting points and the Schutte penetrometer figures show that they advance quite reguarly together. Other experiments have shown this same relation to hold true, provided the free carbon content is very nearly the same. Samples 7 and 8 may then be included in our further examination of the results without introducing undue error.

An examination of the float test shows an increasing interval between samples as we ascend in the series. Between 7 and 8 the interval is 20 sec., while between 10 and 11 the interval is 60 sec.

The results with the Engler viscosimeter show the same tendency much more accentuated. The interval between the samples 7 and 8 is 32 sec., while between samples 10 and 11 it is 96 sec. It is interesting to note that the ratio is the same as in the float test.

A more careful consideration of temperature in testing tar materials with viscosimeters would seem to be indicated. The tars are more sensitive to temperature changes than oils or asphalts, and not enough attention has been paid to viscosity changes with temperature.

The work in Table II. was undertaken to show that, although a specification was rather closely drawn for the Engler reading at 60 deg. C., it yet failed in its object in that it admitted all mixtures of tar H and tar D from 40 per cent. H to 80 per cent. H. Testing the same mixtures at 50 deg. C. shows that the same limit in the upper part of the table would confine the mixture to

*Presented before Section D of the American Association for the Advancement of Science at the Atlanta Meeting, December, 1913.

within 20 per cent., while at 40 deg. C. the same limit would confine it to within 15 per cent.

The table also illustrates again the rapid increase in the time interval as the temperature of the determination of the viscosity approaches the melting point. Thus under 60 deg. C. the space interval is 4.6 for the 50 per cent. H mixture, but this is increased to 25.6 for the 80 per cent. H mixture at 40 deg. C.

The examples that have been cited have been in series of tars of nearly uniform composition. An illustration of the effect of free carbon on the relation between the melting point and the viscosity is given in Table III. The effect of the free carbon is very marked. In the Schutte and float test the times are markedly increased. With the Engler the results are more irregular, but show a marked increase with the high carbon tar. From a physical standpoint, the increase of free carbon might be expected to have this effect. It impedes the flow of the material with increase of temperature, and in that way up to the point at which the free carbon tends to weaken the binding and lasting qualities of the tar would seem to be a desirable addition.

The inclusion of both the melting point and the viscosity in a physical examination of refined tars to be used as binders would seem to be warranted. The viscosity at 100 deg. C. compared with the melting point would give an indication of the behaviour of the tar with uniform distributors, and also an indication of its resistance to temperature changes when used on the road.

In conclusion, first, the viscosity of tars of the same composition varies with the melting point, but not in direct ratio; second, the viscosity of tars of the same melting point but of different carbon content increased with the carbon content.

TABLE I.

A Series of Samples of Refined Tar Made from Same Raw Tar.

Sample No.	Free Carbon.	Distillation. Total to 315 C.	Melting Point.	Schutte Penetrometer.	Viscosity, Engler. 100 c.c. at 100° C.	Float Test at 50 C.
5	12.1	21.8	....	29 sec. at 40° F.	94 sec.	34 sec.
7	12.0	19.2	....	108 " at 40° F.	127 "	38 "
8	14.0	16.4	....	114 " at 50° F.	159 "	58 "
9	14.4	14.9	86.9	85 " at 60° F.	208 "	75 "
10	17.2	12.7	99.7	90 " at 70° F.	335 "	110 "
11	18.2	10.4	108.7	88 " at 80° F.	431 "	170 "

TABLE II.

Comparison of Mixtures of Tar H and Tar D on Engler Viscosimeter. 100 c.c. at Three Temperatures.

Mixture.	Carbon, Est.	40 C.	50 C.	60° C.
40 per cent. H 60 per cent. D	4.4	75.7 sec.	54.6 sec.	41.0 sec.
50 per cent. H 50 per cent. D	5.0	88.1 "	57.0 "	45.6 "
60 per cent. H 40 per cent. D	5.0	97.3 "	62.5 "	47.0 "
70 per cent. H 30 per cent. D	6.2	110.5 "	66.3 "	48.7 "
80 per cent. H 20 per cent. D	6.8	136.1 "	83.3 "	59.0 "

TABLE III.

Refined Tars—Relation of Viscosity to Carbon Content.

Sample.	Free Carbon.	Melting Point.	Schutte Penetrometer at 80° F.	Engler, 100 c.c. at 212° F.	Float Test at 212° F.
1	1.4	110° F.	42.2 sec.	302 sec.	158 sec.
2	14.5	109° F.	80.1 "	298 "	192 "
3	39.6	112° F.	144.9 "	739 "	337 "

The prevention of corrosion of iron in acid waters with an electrolytic method is proposed by the United States Bureau of Mines, which has made experiments with iron submerged in sulphuric-acid solutions. The metal structure to be protected is to be made the cathode of the circuit; that is, current flows from the water to it. The current density and the actual current required for protection can be calculated from experimental data on the loss in weight of the metal when unprotected under the given conditions reproduced as near as possible. This loss in weight per hour per unit area, divided by the electrochemical equivalent (weight dissolved or deposited per ampere-hour) gives the current density to be employed.. This multiplied by the actual area to be protected gives the actual current needed. For good protection, the anodes should be distributed so that the current may not return to the protected structure at one point only.

Interest is being shown at Washington in the great water power possibilities of the St. John River, running between the State of Maine and the Dominion of Canada. Oscar Fellows of Bangor, an official of the St. John River Commission, created by the United States Congress some years ago, but now defunct, told the International Joint Commission at Washington last December that the St. John River ranked close to the Niagara River for its power possibilities. The commission is consequently interested in the question whether or not the river may not be added to its jurisdiction. However, the Webster-Ashburton treaty of the 50's provided that no obstruction should be placed in the St. John River on either side. That prevents power development on the river. But it is expected that in due season Great Britain will be asked to negotiate a new treaty; since Maine and also New Brunswick would benefit from the power developed.

EUROPEAN TUNNELS.

The following is a list of the principal railway tunnels in Europe, compiled by the "Engineer," London:—

Long Tunnels in Europe.

Name	Country	Length miles	Length yds.	Summit level ft.	Opened for traffic
Simplon	Switzerland-Italy	12	458	2,313	1906
St. Gothard	Switzerland-Italy	9	564	[illegible]	1882
Loetschberg	Switzerland	9	55	4,077	1913
Mont Cenis	France-Italy	7	1,730	4,248	1871
Arlberg	Austria	6	404	4,300	1885
Ricken	Switzerland	5	616	650	1910
Tauern	Austria	5	546	4,020	1909
Ronco	Italy	5	277	....	1888
Tenda*	Italy	5	56	3,200	1899
Karawanken	Austria	4	1,683	2,088	1906
Jungfrau*†	Switzerland	4	834	11,220	1912
Borgallo	Italy	4	700	....	1887
Severn	England-Wales	4	[illegible]	....	1886
Turchino*	Italy	4	10	....	1900
Wocheiner	Austria	3	1,047	1,701	[illegible]
Albula*†	Switzerland	3	1,150	[illegible]	[illegible]
Totley	England	3	950	....	[illegible]
Peloritana*	Sicily	3	680	....	1885
Gravehals*	Norway	3	510	2,844	1909
Standedge	England	3	60	....	[illegible]
Woodhead	England	3	13	....	1845
Bosruck*	Austria	2	[illegible]	[illegible]	[illegible]
La Nerthe	France	2	1,581	.	....
Kaiser Wilhelm	Germany	2	[illegible]		[illegible]
[illegible]	France	2	[illegible]		[illegible]
[illegible]	France	2	[illegible]	.	....
Sudbury	England	2	[illegible]	.	[illegible]
[illegible]	France	2	[illegible]	....	....
Vizzavona*†	Corsica	2	[illegible]	[illegible]	[illegible]
[illegible]	England	2	[illegible]	.	1902
Col de St. Michel*†	France	2	[illegible]	.	1901
[illegible]	England	2	[illegible]	.	[illegible]
Festiniog*	[illegible]	2	[illegible]	.	[illegible]
[illegible]	England	2	[illegible]	.	[illegible]
[illegible]	[illegible]	2	[illegible]	....	[illegible]
[illegible]	Italy	2	45	[illegible]	..
Col des Loges*	Switzerland	2		3,200	....
[illegible]	[illegible]	1	[illegible]	....	....
[illegible]	Italy		[illegible]	.	[illegible]
Hauenstein	Switzerland	1	1,210	....	....
Semmering	Austria			[illegible]	[illegible]

Long European Tunnels now Being Constructed.

Name	Country	Length miles	Length yds.
Hauenstein Base	Switzerland	5	0
[illegible]	[illegible]	4	1,512
Grenchenberg	Switzerland	4	0
Puymorens*	France-Spain	3	317
Mont d'Or	France-Switzerland	[illegible]	[illegible]

*Single line tunnel. †One metre gauge railway.

It is reported that no less than 40,000 h.p. will be available from the new power site reserve in Boulder Canon, 2 miles east of Las Vegas, Nev., which the Federal Government of the United States has approved.

The Madrid Ministry of Commerce has ordered plans drawn for a standard gauge railroad of double-track from the French frontier to Madrid. It is calculated to reduce the time occupied in travelling this distance from 13 hours to 7, and from Paris to Madrid from 27½ to 20 hours. It will also be the first European trunk railroad to be operated solely by electricity, and will be state-owned.

Plans for an automobile speedway at Chicago, to cost $750,000, and to rival the one at Indianapolis, have been announced; and a 500-acre tract 27 miles from Chicago, near Joliet, has been purchased. At the head of the syndicate, which purposes undertaking this construction, is J. H. Palmer of the J. H. Palmer Steel and Iron Company. A track will be built 2 miles in length and so banked at the turns as [illegible] speed of [illegible] stand of reinforced concrete will be constructed, which will seat at least 100,000 [illegible].

FUEL SUPPLY FOR THE NAVY OBTAINED FROM CANADIAN OIL SHALES.

In his report, after making a close study of the oil shale fields of Newfoundland and Eastern Canada, in which the Royal Commission appointed by the British Government is interested, Mr. Harold C. E. Spence, says: "Having regard to the importance attaching to the obtaining of large supplies of oil fuel for the navy from sources under the British flag and the comparatively few localities where such sources exist, it is considered of great national importance to preserve for the Empire, such areas of oil shales as are found to contain sufficient volatile matter to prove workable on a commercial scale; and a powerful group of financiers have associated themselves together in London to provide the necessary capital to develop such fields as Sir Boverton Redwood, the technical adviser to the Commission, passes upon.

"The Admiralty have made permanent contracts with the oil shale companies of Scotland to an extent which has caused them to increase the capacity of their plants. These Scotch shales have been worked for 50 years and produce about 60,000,000 gallons of oil per annum with valuable by-products of sulphate of ammonia, etc. The value of oil shales compared with oil wells, is on account of the assured permanency of the output, as on account of the deposits lying almost identically in the manner of coal deposits. The tonnage can be measured approximately and the contents gauged by a system of bore holes, whereas in oil wells there is no way of arriving at the permanency of the flow, some wells and fields becoming exhausted in a few months. In Newfoundland and other places in Eastern Canada, some billions of tons of payable oil shales are assured; and some hundreds of millions of tons are known to contain a far greater percentage of oil to the ton than the successful Scotch fields. There is, therefore, a reasonable hope of a very important industry being inaugurated in the extraction and the refining of oil and the by-products from these shales in the near future."

METHODS OF CHECKING THE ANEROID.

An aneroid barometer is the fastest and most easily portable device for determining elevations. But even during constant weather conditions, it is subjected to changes in pressure equivalent to 50 or 100 feet of elevation, the pressure becoming lowest in the afternoon. It is subject also to the more irregular changes caused by the passage of the cyclonic and anticyclonic pressure areas. (Econ. Geol., October, 1913.) These discrepancies are partly overcome by checking at intervals over points of known elevation, by having a second observer record the readings of another instrument kept fixed, and by keeping the instrument fixed occasionally for short periods of time and noting the rate of change of the readings. A much neater and more satisfactory method of correcting is to use the barograph or recording barometer. This is made in easily portable form and gives an accurate paper record of pressure changes. The instrument can be left at headquarters when a day's work is begun. By noting the times of all readings taken with the field barometer and comparing them with the barograph record for the time in question, the proper correction due to atmospheric changes can be obtained.

Messrs. Ross and Macdonald, architects, have moved their western office from 928 Union Bank Building, to 506 Tribune Building, Winnipeg.

The construction of tank cars, specially equipped for fire fighting, is a new departure on the part of the C.P.R. They are, in general, of the standard construction. They have been built to the designs of the company by the American Car Company; and the idea is to operate them in pairs. Apart from the end arrangement of the auxiliary equipment, they are of identical construction. Each car carries a tank of 8,438 imperial gallons, and on the end of each car there is a 20 by 10 inch duplex fire pump, using steam from the locomotive boiler. The corresponding end of the other car has a rack construction on which can be carried 6,000 feet of fire hose. The car is designed for weight capacity of 100,000 pounds, so standard 50-ton trucks are employed. These tank cars have done good service in the United States.

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CONTENTS OF THIS ISSUE.

THE CAUSE OF RAIL CORRUGATION.

The corrugation of rails has become a rather serious problem in the operation of electric traction. There is considerable doubt as to whether the rail of to-day is sufficiently hard and tough in quality for its work. Investigations organized by numerous associations in various countries have not discovered a solution of the trouble and opinions differ widely as to its cause. Whether modern methods of manufacture, involving as they do the use of large ingots, rapid rolling at high temperature, and consequent absence of homogeneity are not themselves to blame to a large extent for the trouble which the electric railway engineer experiences in the matter of rail corrugation is a question. Of course, experience may have some part to play and it is possible that the railway engineer, after many years of steam railway experience, fails to some extent to grasp the fact that conditions of electric traction differ widely from those which are obtained in ordinary railway work.

In a paper which he read recently before the Institution of Civil Engineers of Great Britain, Mr. S. P. W. Sellon gave it as his opinion that the steel rail now used was not hard enough or tough enough for its work. The use of wheels of small diameter was evidently severe on the rails, but the conditions of electric traction forbade alteration, and the alternative was to find the material which would not yield to the action of the wheels which served to cause corrugation. He expressed his belief that rails with a high percentage of carbon are essential and that they resist corrugating effects as well as ordinary wear.

In his description of the general character of corrugation, Mr. Sellon states that the crests which develop have the appearance of planished or cold-rolled steel and that they are relatively hard and refractory to acid, while the hollows were dull and showed lateral detrusion and pitting. He drew the conclusion that the crests were cold-rolled and the hollows consisted of surface which had been crushed due to the vertical loads imposed by the wheels oscillating about the elastic limit of the steel in compression. It was pointed out that at ordinary speed the usual pitch of the corrugations corresponded with a frequency of about 100 feet per second.

Investigation seemed to show that a comparatively small increase in the compressive strength of the steel would prevent the particular kind of wear which created corrugation in the rail. Mr. Sellon, therefore, suggested that steel with an ultimate strength of 50 or 60 tons per square inch should be used to successfully resist the destructive stresses, the steel at the same time to be devoid of a high degree of ductility. The British Standard prescribes an ultimate tensile strength of 40 tons per square inch, while the actual wear of rails is apparently somewhat in excess of this strength.

The minimum pressure required to produce surface crushing and flowing is apparently in need of early determination. Clauses in rail specifications governing mechanical qualities should obviously bear a direct relation to the stresses which the rail will be called upon to resist. They should be clearly defined to ascertain what portion of rail corrugation is due to abrasion caused by the slip and what to the relative movement between the areas of contact of the wheel-tread and the rail-table in producing a grinding effect. More knowledge on these subjects will assist in finding a rail material that will withstand the actions producing the above defect.

NEW GOVERNMENTAL DEFINITION OF "ENGINEER" IN BRITISH COLUMBIA.

The British Columbia members of the Canadian Society of Civil Engineers have recently shown considerable activity in endeavoring to get the status of the Engineer recognized by the Provincial Government, and, in view of much new legislation involving large engineering projects, several influential deputations of the members, headed by Mr. F. C. Gamble, Chief Engineer of the Department of Railways, and Mr. G. R. G. Conway, Chief Engineer of the British Columbia Electric Railway Company, Limited, the respective chairmen of the Victoria and Vancouver Branches, met the Premier, Sir Richard McBride and the Executive Council and laid before them very strongly the views of the Western members.

It was pointed out that in numerous Acts of Parliament the definition of an Engineer was extremely unsatisfactory. One example given was quoted from the "Ditches and Water Courses Act, 1907," where an Engineer is defined as follows:—

"Engineer means Civil Engineer, Provincial Land Surveyor, or such a person as any municipality may deem competent and appoint to carry out the provisions of this Act."

The effect of this definition in one instance in British Columbia was the temporary appointment by resolution of the Municipal Council of a small contractor to sign plans, and the deputation pointed out to the Ministers that there was nothing in the Act to prevent a Municipal Council from appointing a gardener, blacksmith or carpenter to carry out the duties of the Act as Engineer.

The deputation were accorded a very sympathetic hearing from the members of the Government, and many private members supported their proposals.

Subsequent to the interviews with the Government, a petition was sent to the Premier, signed by every leading Engineer in the Province, asking that the word "Engineer" should be defined in the new Water Act as follows:—

"Engineer means an Engineer of the Water District, who shall be a Civil Engineer who is a member of the Canadian Society of Civil Engineers, or a member of the Institutions of Civil Engineers of Great Britain or of Ireland, or a member of a Civil Engineering Society of equal rank in the British Empire or any foreign country."

This definition was accepted by the Minister of Lands, Hon. W. R. Ross, who, however, felt that while entirely recognizing the principle of the definition, and expressing himself in hearty accord with the objections of the members of the Canadian Society, that special circumstances might arise in which he might be hampered by too strict an observance of the definition. He, therefore, suggested the addition of the following words, which was mutually agreed upon, and now, together with the foregoing, forms part of the Water Act of 1914:—

"But the foregoing definition shall not limit the power of the Lieutenant-Governor-in-Council or the Minister to appoint to any position created under this Act, any person who is, in his opinion, competent to fill such position."

The Western members feel that they are to be congratulated upon the success of their efforts, and hope during the next session to have a similar definition incorporated in the Municipal Act, the Railway Act, and other Acts dealing with engineering undertakings.

LETTER TO THE EDITOR.

Jointing of Water and Gas Mains.

THE spigot and faucet, or the hub and spigot joint, is universally adopted for jointing water and gas mains, and the old method of caulking the joints with spun yarn and lead is still in use everywhere on the globe. The lead melting pot still holds the field.

The reasons for sticking, the world over, to the old approved hub and spigot joint, are various: The easy method of laying; the standardization of fittings, etc., etc.; and last, but not least, the adaptability of the joint to absorb, to a sufficient extent, the contractions and expansions occurring in the mains. There can be little doubt that the hub and spigot joint is, so far, the best joint for municipal gas and waterworks, where the pressure does not exceed 200 lbs. per square inch, provided that the socket and spigot are made strong enough to allow the yarn and lead to be driven home in a proper way; and here lies the weak point about which many complaints are received.

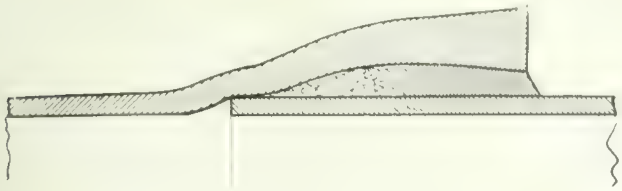
In the case of cast iron pipes, the material is brittle and liable to breakages, i.e., the caulker must not try to strike the lead ring too hard, or else he runs the risk of breaking the socket. The caulking of cast iron pipes requires careful handling, and skilled labor, which is not always at hand in this country.

In the case of steel pipes, the socket is commonly formed by expanding the pipe end. It is quite patent that this is not a very satisfactory process, as the pipe wall is reduced in thickness when expanded, with the result that that part of the pipe which should be strongest, becomes weakest. Manufacturers have been trying to overcome this difficulty by doubling the end of the socket, or by having an iron band shrunk on to the socket end. However, this method of reinforcing has proved to be insufficient, as—especially in the case of the smaller sized pipes—the socket will vibrate during the caulking process; or is liable to deforming, or even splitting, thus causing unreliable or even leaky joints right from the start. Sockets of this kind have given very little satisfaction, and the many complaints have caused manufacturers of steel pipes to look for improvements in this direction.

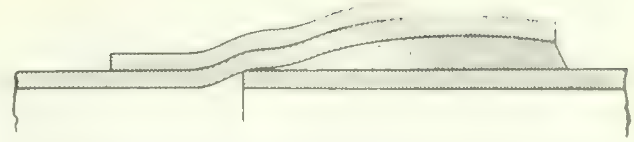
One of the latest proposals is to weld the sockets by the oxy-acetylene process. This experiment, however, cannot be looked upon, seriously, as solving the problem. This idea, which provides for continuous mains, would do away with the principal reason for using hub and spigot joints; i.e., it would not allow of expansion and contraction; and, as iron or steel mains are liable to these movements, something would have to go, no matter how good the joints might be. Furthermore, the welding would be a very big item in the laying expenses, and requires an elaborate outfit, quite apart from the fact the welding of the joints will be very difficult in places. This experiment, therefore, can be discarded as being not practicable.

A strong and solid socket, which requires no delicate handling, and allows of driving home the yarn and lead in such a manner as to make sure of a tight and lasting joint, remains the only solution; i.e., the socket should be reinforced in such a way as to make vibration or deforming and splitting impossible; and the packing space must be of ample depth and sufficient width. The writer inspected, last year, pipes used by the British Columbia Electric Railway Company (Vancouver Gas Company),

which were of a peculiar design. The smaller sizes had a socket reinforced as illustrated hereunder:—



On the larger sizes the sockets were reinforced by a shrunken-on ring, covering the whole length of the socket, and part of the pipe, as follows:—



These sockets looked assuringly strong and well designed, and the writer understands that the joints have given satisfactory results.

HYDRAULIC ENGINEER.

Montreal, March 21st, 1914.

C.N.O.R. BRIDGE OVER EAST STURGEON RIVER.

THE bridge across the East Sturgeon River, at mileage 250 from Ottawa, on the Ottawa-Capreol line of the Canadian Northern Ontario Railway, has just been completed. The accompanying drawings, showing the bridge in plan and elevation, together with the photographs, give some idea of its general design and methods of erection.

The deep and swift current which the river possesses at this point, together with the fact that it is subject to a rapid rise of several feet, rendered the construction of this crossing somewhat difficult. Accessory to these conditions the bridge is built at an angle of 60° with the centre line of flow of the stream.

Foundation work was rendered difficult owing to the presence of huge boulders and rock in deep water. In order to avoid, as far as possible, the necessity of constructing costly falsework for a truss, it was decided to use long deck plate girder spans. The crossing comprises four of them, two 130-ft. deck plate girder spans across the stream and one 80-ft. span of similar type at each end. After the contract had been awarded, however, the Canadian Bridge Company decided that it would be preferable to construct falsework over the stream, notwithstanding the fact that the contract had been awarded for the long spans with the expectation that only a small amount of falsework would be necessary.

The method of erection adopted was to unload the girders on blocking near the site and to completely rivet each pair before lowering them to the line of track. Two additional rails had been laid about 12 in. outside of the standard gauge rail, which gave a sufficiently wide and satisfactory base. Five bolsters of 14-in. x 14-in. timber, with steel shoe plates, were attached to the underside of the girders resting upon the rails, the latter being well lubricated. In this way a set of girders was moved through a distance of about 600 ft. over the approach

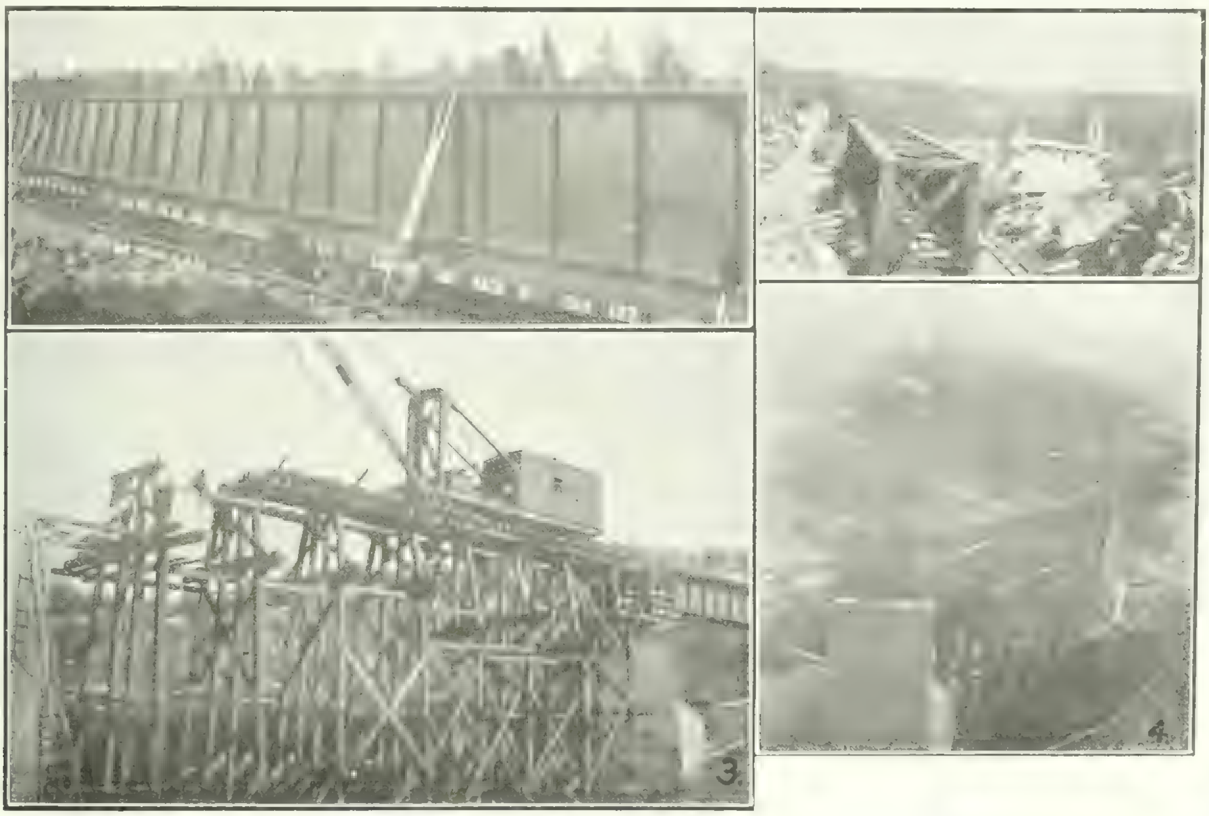


Fig. 1.—A 130-ft. Girder on Cars. Fig. 2.—Span (130 ft.) assembled.
Fig. 3.—Construction of Falsework. Fig. 4.—A 130-ft. Span being moved into position over piers.

and falsework in the stream, and into position over the piers. The power used for moving the girders over the falsework was obtained from a derrick car engine, a three-quarter-inch cable with two sheave blocks being used for the purpose. The girders were moved about 100 ft.

Fig. 5.—One of the 130-ft. Deck Plate Girder Spans Resting on Blocking on Piers, over Falsework.

without adjusting the blocking and cable, the whole operation of moving these over 600 ft. taking about one and one-half days. The high blocking over the piers, being at a height of about 35 ft. above water level, made the process of lowering the girders somewhat slow. To prevent any undue stress being brought on any of the parts of girders a harness was made of timber, which served the purpose quite well. One end was lowered 14 inches at a time, the lowering being accomplished by the use of four 40-ton jacks. The weight of each 130-ft. span is approximately 280,000 lbs. The 130-ft. girders are spaced 9 ft. centre to centre with ties 10 in. x 12 in. x 14 ft. The bridge is designed for Class "Heavy" Loading, Dominion Government Specifications, 1908. The total weight of the steel in the crossing is 745,000 lbs. The total amount of concrete used in the substructure was 1,725 cu. yds.

The complete structure cost in the neighborhood of $70,000. The Canadian Bridge Company, Walkerville,

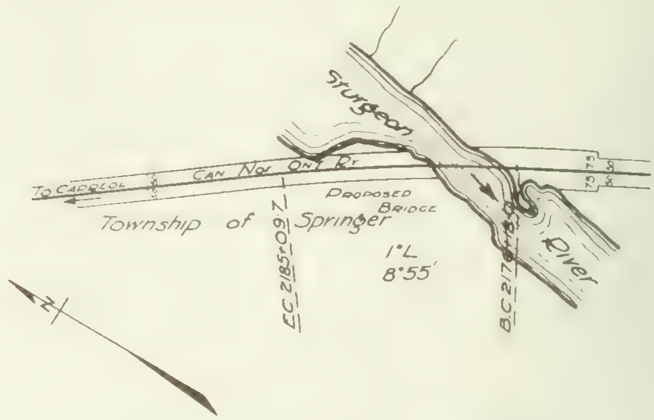


Fig. 7.—Showing Bridge Location.

was awarded the contract for the furnishing and erecting of the superstructure, which was delivered and erected without mishap, despite the difficulties which the site presented. The substructure was built by R. S. and J. H. Henderson, sub-contractors under The Angus Sinclair Company. Mr. J. C. Smith had charge of the erection for the Canadian Bridge Company. The work was carried out under the direction of A. F. Stewart, Chief Engineer, Canadian Northern Ontario Railway, and W. P. Chapman, Engineer of Bridges, Mackenzie, Mann & Company, Limited. We are indebted to the latter for the description of this work and the photos accompanying it.

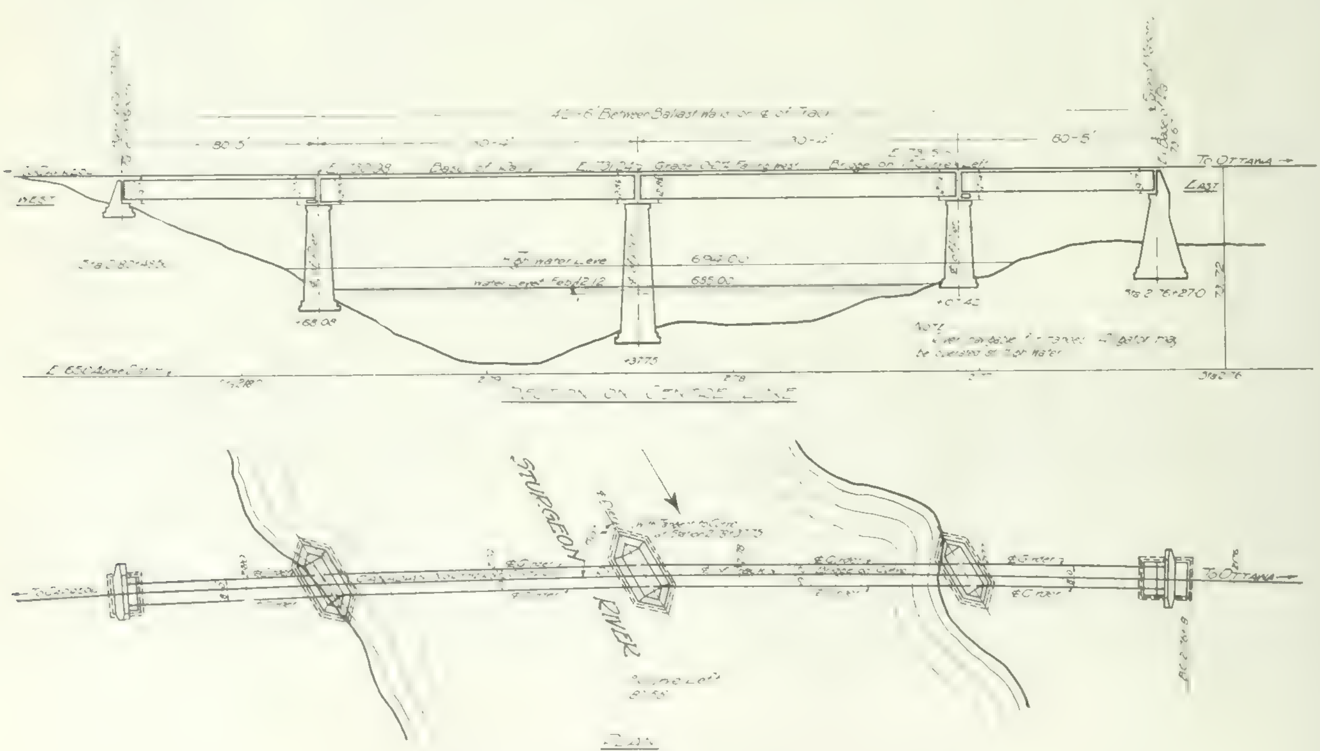


Fig. 6.—Plan and Elevation of Sturgeon River Bridge.

HISTORY OF THE CONSTRUCTION OF BROKEN STONE ROADS.*

By R. L. Morrison,
Graduate Student in Highway Engineering, Columbia University, New York City.

THE first broken stone roads were built in France in 1764 by Pierre Marie Jerome Treseguet, who was then Chief Engineer of the District of Limonges. Previous to that time there were few improved roads in France. The Corps de Ponts et Chaussees had been organized in 1716, the year of Treseguet's birth, but most of the roads, according to a writer of the time, were in a "state of nature or worse." Where road improvement was attempted at all it was done by what was known as the Roman method. An excavation was made, forming a flat sub-grade, and on this was placed the foundation of the road, which consisted of two or more layers of large, flat stones. This foundation was eighteen feet wide and about ten inches deep, and was covered with a layer of small stones, which were spread and then beaten down and broken in place with hammers. The surface was finished with a thin layer of stones smaller than the underlying material and consolidated by traffic. The total thickness of the road was usually 18 to 20 inches at the centre and about 12 inches at the sides. While these roads, when completed, contained more or less broken stone, it was not an essential feature of their construction.

The large amount of material used made these roads very expensive to build, and, owing to the lack of proper maintenance, they were soon cut by deep ruts. All road work was done by means of the corvee, a system of compulsory labor, which was available only twice a year, so that when repairs were made, large quantities of stone were required.

In the District of Limonges the corvee was abolished in 1764, so cheaper methods of construction and maintenance became necessary, and this necessity was met by Treseguet with the broken stone road. His method of construction was a modification of the Roman method, and is described by the originator as follows: "The bottom of the foundation is to be made parallel to the surface of the road. The first bed on the foundation is to be placed on edge, and not on the flat, in the form of a rough pavement, and consolidated by beating with a large hammer, but it is unnecessary that the stones should be even, one with another. The second bed is to be likewise arranged by hand, layer by layer, and beaten and broken coarsely with a large hammer, so that the stones may wedge together and no empty space may remain. The last bed, three inches in thickness, is to be broken to about the size of a walnut, with a small hammer, on one side of a sort of anvil, and thrown upon the road with a shovel to form the curved surface. Great attention must be given to choose the hardest stone for the last bed, even if one is required to go to more distant quarries than those which furnish stone for the body of the road; the solidity of the road depending on this latter bed, one cannot be too scrupulous as to the quality of materials which are used for it."

Treseguet was also the first to propose a system of continuous maintenance, and fought with energy the old method of intermittent repairs.

In 1775 he was made Inspecteur General des Ponts et Chaussees. In the same year the corvee was abolished in all of France, and the following year Treseguet's method of construction was officially adopted.

England failed to profit by Treseguet's invention, and at the beginning of the nineteenth century the methods of road improvement and repair were similar to those discarded in France a generation before. In building a road a trench was dug and large masses of stone put into it. Over this foundation were spread thick layers of broken stone, and the surface was finished with an extremely high crown, approaching a semi-circle in form. This crown was composed of earth, rushes, stones and various other materials, and was covered over with a small quantity of gravel. As a result all traffic was forced to keep to the centre of the road, the sides being dangerous.

Deep ruts were formed, which retained water and mud, and the road soon became impassable. On account of robbers and the bad state of the roads wills were always made previous to undertaking a long journey by stage-coach.

The man whose skill as a road builder changed this deplorable state of affairs, and whose name has been generally applied all over the world, in the form of noun, adjective and verb in connection with broken stone road construction, was John Loudon McAdam, who was born at Ayr, Scotland, in 1756. Much of his youth was passed in the United States but he returned to Scotland in 1783 and became road trustee and manager of a district in Ayrshire.

Between the years 1798 and 1814 McAdam travelled about 30,000 miles over the roads of Great Britain making investigations, and during this time he originated the system of road-making now known by his name. In 1815 he was appointed surveyor of roads in Bristol, and there his system of construction and repairing reached its highest development.

This system was founded upon the theory, as stated by McAdam, that "The roads can never be rendered perfectly secure until the following principles be fully understood, admitted, and acted upon, namely, that it is the native soil which really supports the weight of traffic; that while it is preserved in a dry state, it will carry any weight without sinking, and that it does, in fact, carry the road, and the carriages also; that this native soil must previously be made quite dry, and a covering, impenetrable to rain, must then be placed over it, to preserve it in that dry state; that the thickness of a road should only be regulated by the quantity of material necessary to form such impervious covering, and never by any reference to its *own* power of carrying weight."

He severely condemned the use of large stones under any circumstances, in any part of the road, and said that every stone exceeding one inch in any dimension was mischievous.

Regarding the body of the road, the report of a special committee of parliament in 1823 says: "It appears that Mr. McAdam first directed the public attention to this important fact, that angular fragments of hard materials, sufficiently reduced in size, will coalesce or bind, without other mixture, into a compacted mass of stone nearly impenetrable to water, which, being laid almost flat, so as to allow of carriages passing freely upon all parts of the road, will wear evenly throughout, not exhibiting the appearance of ruts or of any other inequalities."

McAdam wrote several essays and reports on highways, and gave the following directions for road-building: "The first operation in making a road should be

*Presented before Section D of the American Association for the Advancement of Science at the Atlanta Meeting, Dec., 1913.

the reverse of digging a trench. The road should not be sunk below, but rather raised above, the ordinary level of the adjacent ground; care should at any rate be taken that there be sufficient fall to take off the water, so that it should always be some inches below the level of the ground upon which the road is intended to be placed; this must be done, either by making drains to lower ground, or if that be not practicable, from the nature of the country, then the soil upon which the road is proposed to be laid must be raised by addition, so as to be some inches above the level of the water.

"Having secured the soil from *under* water the road-maker is next to secure it from rain water, by a solid road, made of clean, dry stone, or flint, so selected, prepared, and laid, as to be perfectly impervious to water; and this cannot be effected unless the greatest care be taken, that no earth, clay, chalk, or other matter, that will hold or conduct water, be mixed with the broken stone; which must be so prepared and laid, as to unite by its own angles into a firm, compact, impenetrable body. Nothing is to be laid on the clean stone on pretence of *binding*."

As a rule the metal on McAdam's roads was 16 feet wide, with 6-foot shoulders of softer materials. The depth of the metal was from 7 to 10 inches, and the roads were usually built in three layers. The crown was 3 inches for a width of 18 feet.

The sizes of broken stone used he described as being of six ounces weight, and he always made his surveyors carry a pair of scales in their pockets to use in testing the sizes.

McAdam sometimes used gravel instead of broken stone, but it appears that this was done usually in cases where local conditions, including legal restrictions, made the use of broken stone impracticable. In his directions for road work, in 1811, he said: "Every road is to be made of broken stone," and in testimony before a committee of parliament in 1819 he said: "Now the principle of road-making I think the most valuable, is to put broken stone upon a road, which shall unite by its own angles, so as to form a solid, hard surface; and, therefore, it follows, that when that material is laid upon the road, it must remain in the situation in which it is placed without ever being moved again; and what I find fault with putting quantities of gravel on the road is, that before it becomes useful it must move its situation and be in constant motion.

"In digging the gravel near London, and places where there are vast quantities of loam, and that loam adhering to every particle of the gravel, however small, I should recommend to leave the very small or fine part of the gravel in the pits, and to make use of the larger part, which can be broken, for the double purpose of having the gravel laid on the road in an angular shape, and that the operation of breaking it is the most effectual operation for beating off the loam that adheres to the pieces of gravel."

It is obvious that this "gravel in angular shape" was really broken stone, and it is possible that in other cases where McAdam referred to gravel he meant broken gravel.

Where the substratum was unsound the usual custom was to cover it first with a layer of faggots and brush. On this was placed a layer of large, flat stones, then a layer of smaller stones, and finally eight or ten inches of broken stone. In such cases McAdam, however, used no faggots, large stones, or other special foundation, and he said that he would actually prefer a soft sub-grade, or even a bog, for his ordinary roads. He claimed that a road on a hard foundation was quickly worn out, but that on the softest ground the foundation never sank.

Methods of repairing roads were carefully studied by McAdam, and he gives the following directions for this work:—

"No addition of materials is to be brought upon a road, unless in any part of it be found that there is not a quantity of clean stone equal to ten inches in thickness.

"The stone already in the road is to be loosened up and broken, so as no piece shall exceed six ounces in weight.

" . . . The stones when loosened in the road are to be gathered off by means of a strong, heavy rake, with teeth two and a half inches in length, to the side of the road, and there broken, and on no account are the stones to be broken on the road.

"When the great stones have been removed, and none left in the road exceeding six ounces, the road is to be put in shape and a rake employed to smooth the surface, which will at the same time bring to the surface the remaining stone, and will allow the dirt to go down.

"When the road is so prepared, the stone that has been broken by the side of the road is then to be carefully spread on it; this is rather a nice operation, and the future quality of the road will greatly depend on the manner in which it is prepared. The stone must not be laid on in shovels full, but scattered over the surface, one shovel full following another and spreading over a considerable space.

" . . . The object to be aimed at is to keep the natural soil dry, and this must be done both by defending it from ground water, and from that which falls from above. In the knowledge of the measures requisite to effect those objects consists the whole science of road-making."

McAdam turned his attention not only to methods of construction and maintenance, but to questions of road administration, legislation, and finance. He was engaged as general surveyor by many of the road trusts of England and Scotland, and his system proved so beneficial that he built up a world-wide reputation. In 1820 his work began to attract attention in France, and in 1830 his system was officially adopted in that country. He died in 1836.

It is very probable that McAdam was not actually the inventor of the method of construction he employed. The Westminster Review in 1825 states that this system had long been in use in Sweden, Switzerland and other countries, and in his testimony before the Parliamentary Committee in 1819 one John Cripps, Esq., said: "I had an opportunity of observing in Sweden that the roads were more beautiful than any I ever beheld; they are formed in the same manner as by Mr. McAdam, the materials broken extremely small. The material is the best in the world, as it is rocks of granite; and so well do they understand the necessity of breaking them small, that you never behold, throughout Sweden, a fragment of granite larger than the size of a walnut, for the purposes of the road. To the eye the roads appear perfectly flat; but upon trial by the spirit level there is a slight degree of convexity."

Another road builder, whose fame is exceeded only by that of his contemporary, McAdam, was Thomas Telford. He also was a Scotchman; he was born one year after McAdam and died two years earlier (1757-1834). He received the rudiments of an education in the parish school of Westerkirk, learned the trade of a mason, and later studied architecture in Edinburgh and London. It was as a bridge builder that he first became widely known. In 1787 he was appointed Surveyor of Public

Works in Shropshire, where he built many fine bridges and excellent roads. His greatest work was in the Highlands of Scotland, where he was sent by the Government in 1802 to report on the best means of developing the country. He recommended an extensive road system, and under his direction nearly a thousand miles of gravel road were built and more than a thousand bridges. This work extended over a period of eighteen years and cost 2¼ million dollars. Telford's specifications for these roads are given by Aitken, and they include minute details of parapet walls, drains, etc.

Apparently the first broken stone road built by Telford was that between Glasgow and Carlisle. This work was done in 1816, and involved extensive reconstruction of the old road. The distance was reduced from 102 miles to 93 miles, which necessitated the entire reconstruction of 69 miles of the road and the building of fifteen new bridges. The maximum gradient of the new road was 1 in 30. The cost, exclusive of bridges, was $5,000 a mile.

It was specified that "the breadth was to be 34 feet between the fences, 18 of which were to be metalled, and the remaining 8 feet on each side to be covered with gravel.

" . . . The metalling to consist of two beds or layers, viz., a bottom course of stones, each 7 inches in depth, to be carefully set by hand, with broadest end downwards, all cross-bonded or jointed, and no stone to be more than 3 inches wide on the top. These stones to be either good whinstone, limestone, or hard freestone; the vacuities between to be carefully filled with smaller stones packed by hand, so as to bring the whole to an even and firm surface.

"The top course or bed to be 7 inches in depth, to consist of properly broken stones, none to exceed 6 ounces in weight, and each to pass through a circular ring 2½ inches in diameter in their largest dimension. These to be of hard whinstone, the quality of both bottom and top metal to be determined by the inspector. In every 100 yards in length on each side of the road, upon an average, there was to be a small drain from the bed of the bottom layer to the outside ditch, as directed by the inspector. When the height of the embankments exceeded 3 feet, they were to stand from 1 to 3 months, in proportion as they increased in depth, as determined by the inspector. Over the upper bed, or course, of metal to be a binding of gravel of 1 inch in thickness upon an average; the cross-section of the finished roadway to have a curvature of 6 inches; in the middle 18 feet, and from that on each side a declivity at the rate of half an inch in a foot, to within 18 inches of the fences; the remaining space of 18 inches to have a curvature of 3 inches, making, in all, about 9 inches on each side below the finished roadway."

Cross-drains, nine to every mile, were to be placed under the road, and were to be 18 inches wide and from 16 to 22 inches high. The manner of contructing these drains was carefully specified.

The principal difference between Telford's form of construction and that of Treseguet was that Treseguet made his sub-grade parallel to the finished surface of the roadway, while Telford used a flat sub-grade. McAdam differed from both in omitting the large foundation stones.

On a portion of the Highgate Archway Road Telford used a 6-inch concrete foundation, composed of one part Roman cement to eight parts of washed gravel and sand. Transverse channels were cut in the surface four inches apart, and inclined toward the sides. These channels were for drainage, and also served to keep the broken stone in place on the concrete.

This road was a great success, and on another road a similar foundation of a 1 to 4 lime and gravel mixture was used. This was covered with 6 inches of broken stone, built in two layers. Wherever used this method was successful, and ten years after Telford's first experiment in 1828, Thomas Hughes wrote: "I am decidedly of opinion that this material, if generally adopted as a foundation for roads, will effect one of the greatest improvements that has for many years been presented to the notice of the public."

Most of the stone-breaking for the McAdam and Telford roads was done by women, old men, and boys.

Edgeworth wrote in 1817: "Attempts have been made some years ago to break limestone for roads by the force of horses, wind, and water. Stampers, shod with iron, and raised by proper millwork, were employed, and they were let to fall upon blocks of whinstones. These mills . . . crushed the stone to dust rather than to fragments if lighter stampers were employed, they frequently failed to break the stone. Feeding the mill was also found difficult and dangerous."

Successful experiments with a steam-driven roller crusher were made previous to 1844.

Quarrying was done with crowbars and picks until about 1840, when blasting began to be used.

The spirit level was first used on highway work in 1790, and the later roads were often carefully surveyed.

In 1817 Philip Clay invented "a harrow which is intended to scarify the uneven part of the road." Little improvement was made in scarifiers until comparatively recent years.

Road templets were in use in 1838.

The machine which has had the greatest influence upon methods of road construction is the roller. In 1619 one John Shotebolte wrote of using "land stearnes, scowrers, trundlers, and other strong and massy engines," but the first practical horse-roller was made in France in 1787. Thirty years later the roller was introduced into England, but it was not widely used in that country until 1843, when Sir John Burgoyne wrote a pamphlet on the subject of road-rolling.

The first steam roller was invented in France in 1859, and their use soon spread to other countries.

France has always been the leader in road-building, and the French method of construction, as described in 1843, contained most of the essential elements of the modern road. These roads were from 4 inches to 8 inches in thickness, and when over 4 or 5 inches thick were built in two layers. The road was thoroughly watered and rolled, first with an empty roller weighing 3 tons, then with the cylinder filled to weigh 6 tons, and finally with the roller loaded to a weight of about 10 tons.

The stone was broken to a maximum size of 2½ inches. The smallest *debris* of broken stone was saved and spread on top, with water, at intervals during the rolling.

English writers a generation later had few improvements to suggest, and gave the above as the best practice known, except for minor changes due to the introduction of the steam roller and the improvement of other road machinery.

In fact, an attempt to trace the history of further development of construction methods would be more properly classed as a discussion of modern practice.

No allusion has been made to American roads, because, during the period covered, the improved roads of

this country were very much like the famous snakes of Ireland—noted for their absence. Two events may be mentioned, however, as being of special importance in the history of broken stone roads in the United States. They are the building of the first road of this type, the Lancaster Turnpike, in 1792, which for several years was simply a gravel road; and the granting of the first patent for a steam roller in 1873.

COST OF LOS ANGELES AQUEDUCT.

An article dealing with the completion and operation of the Los Angeles aqueduct was published in *The Canadian Engineer* for January 9th, 1913. Recently some interesting figures have been published in the last annual report of the aqueduct organization and appear below. It would appear that the undertaking has been completed none too soon as the report describes the rapid increase in territory served by the city plant and the difficulties which the municipalities taken in have had in supplying themselves.

The report gives all the items of the cost as follows:

The first issue of Aqueduct bonds, expended in preliminary surveys, purchase of lands in and above Owens Valley, water rights, rights of way, etc. ....$	1,500,000.00
The second issue, $23,000,000, expended in construction of aqueduct, minus $61,000 on hand and $700,000 of salvage	22,239,000,00
Aqueduct liabilities unpaid as hereinbefore set forth	490,000.00
	$24,229,000.00
Paid out of Water Revenue Fund as follows:	
One-half of Mr. Mulholland's salary during period of construction of aqueduct..$	52,500.00
Purchase price of San Fernando Reservoir site	126,000.00
Cost of San Fernando dam to date	319,785.73
Interest on Aqueduct bonds paid by tax moneys, up to May 12, 1913	3,110,057.93
Making total cost of the aqueduct ....$	27,837,343.66

The original estimates, represented by the $24,500,000, have been exceeded some 3⅓ million dollars, including the payments of interest. Work not included in those original estimates includes about a million dollars spent in additional cover over the aqueduct, and the San Fernando reservoir work in the table, in all some $1,500,000.

TREATMENT OF TITANIFEROUS ORES.

Many deposits of titaniferous magnetite, some of them very large, have attracted considerable attention as possible sources of iron. With present furnace practice, however, reduction of ores carrying more than a small percentage of titanium is difficult and expensive, and consequently such ores are refused by the furnaces. In its endeavor to bring about the utilization of undeveloped mineral resources in the United States, the Bureau of Mines completed an investigation in relation to the treatment of titaniferous iron ores by magnetic concentration. The results of this investigation, which was conducted by J. T. Singewald, Jr., have been transmitted for publication in bulletin form.

An investigation of the possibility of utilizing titaniferous magnetites in the electric furnace for the direct manufacture of iron-titanium alloys, such as being used in making special grades of steel, is to be undertaken by the bureau.

MUNICIPAL ELECTRIC POWER STATIONS IN THE UNITED STATES.

Preliminary figures of the forthcoming report on the municipal central electric light and power stations of the United States have been given out by Director Harris of the Bureau of the Census, Department of Commerce Municipal stations are those operated under the ownership of municipalities or other local governments. They do not include electric plants that were idle or in course of construction.

As a rule, no cash income is derived by municipal stations for electrical energy used for lighting streets and public buildings, and in order that the income shown may approximate the total consumption and sale of electric current by these stations the schedule required that the income for service of this character should be estimated on the basis of what would have been charged for similar service by commercial companies in nearby localities. The number of persons employed may fall short of the total number actually engaged in work in connection with the operation of the electric stations, because the services of employees for the electrical work often are not required for long or continued service, and they are reported with that branch of municipal work with which they are chiefly employed.

The figures as presented for the United States show substantial gains for the decade 1902-1912. The number of stations increased from 815 in 1902 to 1,562 in 1912, or 92%; the total income for 1912 amounted to $23,218,989 as compared with $6,965,105 in 1902, or an increase of 233%; the total expenses for 1912 amounted to $16,917,165 as compared with $5,245,987 in 1902, or an increase of 222%. The total number of persons employed numbered 7,940 in 1912 as compared with 3,417 in 1902, or an increase of 132%; the total horse-power of the power plants was 559,328 in 1912 as compared with 160,028 in 1902, or an increase of 249%; the horse-power of the water wheels increased from 11,218 in 1902 to 130,261 in 1912, or 1,061%; the output of stations in 1912 was 537,526,730 kw. hours as compared with 195,904,439 in 1902, or an increase of 174%. The estimated number of arc lamps wired for service was 91,851 in 1912 as compared with 50,795 in 1902, or an increase of 81%; all other varieties of lamps wired for service, numbered 7,057,849 in 1912 as compared with 1,577,451 in 1902, or an increase of 347%; the horse-power capacity of the stationary motors served with electric current was 164,291 in 1912 as compared with 3,324 in 1902, or an increase of 4,843%.

There was an increase of 310 stations in 1912 as compared with 1907, accounted for as follows: New stations, 301; from commercial to municipal stations, 106; from municipal to commercial, 80; and 17 stations reported in 1907 that were out of business or not in operation in 1912.

A comparison of the C.P.R. tunnel at Roger's Pass through the Selkirk with other tunnels of world-wide fame is interesting. The greatest tunnel in the world is the Simplon Pass tunnel, which is 13 miles long. Then comes the St. Gothard and the Mont Cenis. The longest tunnel in the United States is the Hoosac, which is 4 miles long. The C.P.R. tunnel in the mountains will be the biggest thing on this continent and the most difficult accomplishment. The C.P.R. has one great advantage over any other system in respect of the operating of the trains through the tunnel. It will make its own power from the electric energy stored in the heart of the mountains.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

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BOOK REVIEWS.

Village Electrical Installations.—By W. T. Wardale. Published by Whittaker and Company, London and New York. 80 pages and 12 illustrations; 5⅛ x 7½ in.; cloth. Price, 58 cents net.

This book is written in very simple, non-technical language, and would no doubt prove interesting and useful to the members of a village council who wished to get a general idea as to what might be done in the way of providing electric lighting in their district.

The author rightly insists on the services of an engineer being requisitioned before proceeding with any particular scheme. On the whole, the book would not be of much use in this country owing to the entirely different practices obtaining here in electrical work as compared with England. The illustrations are good and the information given is, so far as it goes, accurate.

The "Mechanical World" Pocket Diary and Year Book for 1914.—Published by Emmott and Company, Limited, 65 King Street, Manchester, Eng. Norman and Remington, 108 North Charles Street, Baltimore, U.S.A., American selling agents. Price, 25 cents.

It speaks well for the popularity of this book that it is now in its twenty-seventh year of publication. Although no doubt somewhat more useful in Great Britain than on this side of the Atlantic, it will be found a handy reference book even here, as it contains a great deal of useful and reliable information.

Apparently since last year arrangements have been made for its sale on this continent as indicated above, and its low price is greatly in its favor.

Each year this little work is kept up to date by the rewriting of some sections and the addition of much new matter.

For 1914 the section on Steam Turbines has been rewritten; new sections added are those on Milling and Gear-cutting on the Milling Machine and on Grinding, while among other things tables of American Screw Threads have been inserted. The publishers invite suggestions, hints and corrections.

The "Mechanical World" Electrical Pocket Book for 1914.—By the same publishers. Price 25 cents.

This is a publication on exactly similar lines at the same price as the "Mechanical World" Pocket Diary. Like its older companion, it is revised and brought up to date each year, the new features in the present issue including sections on Telephones, the Electrical Equipment of Ships, Lifting Magnets, Dry Batteries, etc.

Practical Pattern Making.—Second edition.—By F. W. Barrows. Published by Norman W. Henley Publishing Company, 132 Nassau Street, New York. 331 pages; 5 tables; 160 illustrations; 5 x 7 in.; cloth. Price, $2.00.

That practical knowledge and sound common sense are possessed by the author of this book is evident all the way through. The style, for it has a style of its own, is chatty without being vapid, and a great deal of useful information is imparted without our being aware of it.

Youths learning their trade could peruse the book with much profit, especially if they would take to heart the little bits of worldly wisdom which are peppered over the pages here and there, as well as merely the items which deal with the avowed subject-matter of the book; older heads will not be likely, of course, to gain so much, but as there are generally more ways of killing a pig than by hanging it, even they may find described some other, and perhaps better, method of doing a certain piece of work than their own. Information is given on Materials and Tools used in Pattern-making, as well as how best to utilize and handle them.

Examples, many of them clearly illustrated, of various kinds of wood and metal patterns, together with gating, plate work and plaster work, are given. The book closes with a section on the cost, marking and recording of patterns; depreciation tables showing the value in any given year, with a certain assumed life, are here included.

The author is not without a sense of humor, which crops up every now and then, as, for instance, where he tells us that when there are only two boards to choose from it is sometimes a difficult matter to decide which to use, for, "sometimes, it must be confessed, it seems as though each one of the two was a little worse than the other."

Electro Thermal Methods of Iron and Steel Production.—By J. B. C. Kershaw, F.I.C. Published by Constable and Company, London. 233 pages; 100 illustrations; 50 tables; 6 x 9 in.; cloth. Price, $2.25.

Reviewed by T. R. Loudon, of James, Loudon and Hertzberg.

In the preface of this book it is pointed out that there has been a long-felt desire for a practical work on electric furnace iron and steel production. The point of this statement, of course, lies in the exact definition of the word "practical." It is well recognized by iron and steel men that, unfortunately, a great deal of the published material relating to electric furnaces is hardly unbiased, and that the results given are not what one might call practical from a commercial standpoint. It was evidently the author's intention to publish merely the data that was authentic and of a practical nature. The author states that he is not connected in any way with any of the patentees of the furnaces described.

The first chapter is purely introductory. Chapter II. is devoted to general principles and methods. The principles as outlined are well stated, but are necessarily fragmentary owing to limited space. It is emphatically pointed out that the function of the electric current is purely to give heat.

This, of course, is well understood by those experienced in metallurgical work, but, unfortunately, is not always sufficiently emphasized, with the result that in many cases a misapprehension often arises as to the effect of the electric current on the resultant metal itself.

Chapter III. deals with smelting furnaces. A description of the early attempts at smelting is given, together with the reported cost data of the various experiments. This is followed by descriptions of the Grönwall furnaces in Sweden and the smelting operations at Shosta, California. These descriptions and results are mostly taken from published articles which are very familiar to anyone interested in this question. There are also descriptions of the Frick and Chaplet furnaces. The Heroult steel refining furnace is described in Chapter IV., various installations which are well known being discussed. In the same way, Chapters V. and VI. deal with the Girod and Stassano furnaces, respectively. It is unfortunate that the Kjellin and Röechling-Rodenhauser furnaces have been described in the same chapter. As is well known, the latter furnace is not a true induction furnace, while the Kjellin is a perfect example of the much-debated induction furnace.

In Chapters VIII. to X. various furnaces, such as the Keller, and a number of furnaces not very well known, are described. The author describes the Colby furnace among this latter group, using, by the way, the same old familiar cut as an illustration. This furnace might better have been placed with the Kjellin.

Power consumption and running costs are discussed in Chapter XI.

The book is well published, the paper being high grade and the illustrations clear. The material is very largely taken from well-known descriptions in the various technical journals. The book is a good catalogue of these articles.

Mechanical Laboratory Methods of Testing Machines and Instruments.—By Professor Julian C. Smallwood, Syracuse University, N.Y. Published by D. Van Nostrand Company, New York, N.Y. 333 pages; illustrated; 5 x 7½ in.; cloth. Price, $2.50 net.

The author of this book has produced a brief treatise on the mechanical laboratory methods of testing apparatus and machines, and he has entered a field in which there appears to be ample room for a well-written book. So far, outside of a few comparatively large books, there are very few concise and handy works. There is still room for a good book specially written for the use of practising engineers.

The present book has been very nicely gotten up, and is printed in good type. It is divided into three main parts, dealing, respectively, with the calibration of instruments, the analysis of fuels and the products of combustion and the testing of power plant units, with an appendix discussing the reports of tests and methods of conducting students' tests.

In the part dealing with the calibration of instruments, and which occupies over 130 pages, almost every possible measuring device used in mechanical engineering has been taken up. The instruments include scales, gauges, brakes, dynamometers, indicators, planimeters, meters, nozzles, etc., calorimeters and oil and belt testers. To explain the method of treatment the Pilot tube may be taken as an example. In dealing wih this there is, first, a brief discussion of the principles on which it works, then the method of finding by its aid the mean velocity and the location of the point of mean velocity in the pipe. Each instrument is dealt with similarly.

The section on combustion is brief, but deals fairly fully with questions relating to the action of fuels and the calculations relating to their use.

In the last part, on the testing of power plant units, each type of unit is taken separately, and the standard methods of testing and analyzing the results are fully described. Taking the steam engine as an illustration, the matters dealt with are: clearance, valve-setting efficiency and economy, and the machines examined in this way include also steam pumps, boilers, gas engines, air-compressors, fans, water and steam turbines, centrifugal pumps, etc.

The book will prove of help to all engineering students, and the information contained is of such a nature as to be suggestive to engineers who do a reasonable amount of testing.

The Mechanical Engineers' Reference Book.—By Henry Harison Suplee, B.Sc., M.E. Fourth edition, revised and enlarged. Published by Charles Griffin and Company, Limited, London, and by J. B. Lippincott Company, Philadelphia, Pa. 1914. Price, $5.00.

This book differs, in some ways, from ordinary engineering hand-books. It is practically a book of tables, formulas and methods, for engineers, students and draughtsmen. It is intended to be the legitimate successor of Nystrom's Mechanics, which was, in its day, a most useful and handy compendium of information on all subjects connected with engineering. Suplee's work is of convenient size, and has a table of contents and a detailed index. The first page of each of the principal sections, fifteen in all, are "thumb-cut," so as to be easily found and opened without special reference to the index.

In dealing with mathematics—the first of the larger sections—short cuts are given, and handy "kinks" for quickly getting results, without a repetition of "what we may" call "common knowledge." In handling the subject of mechanics, the consideration of the theory of the science is taken up and developed so that it leads to the statics of framed structures, and thus deals with roofs of buildings and with bridges. Dynamics is included in this section, and explanations of all the units, such as that of force, work, power, momentum, etc., etc., are given.

In the section known as Mechinical Engineering, a mass of constantly used matter has been compressed into small space. There is, first, the materials of engineering, tables of weights of pipes, bars, bolts, etc., specific gravity of various substances, facts about pipes, couplings, bolts, nuts, wire rope, followed by the hundred-and-one things which crop up in the engineer's daily life. The strength of materials deals with matters concerning tension, compression, bending, shearing, torsion, and the elements of structural material. Machine design takes up a most important subject to the mechanical engineer. Formulas are given and methods indicated by which the strength of so simple a tool as a wrench may be calculated and properly designed. Keys, key-ways, journals, shafts, bearings, teeth of wheels, belts, rope-drives, and many kindred topics are treated in this practical and easily understood way.

The sections on heat, air, and water give facts which are necessary to be known. Fuel contains many useful tables of the calorific value of combustibles, solid and liquid. Steam follows, with useful tables and information of a thoroughly practical kind. There is a section devoted to steam boilers, and in it tables of various kinds are set down, and information is placed before the reader concerning evaporative power, cost of gaining evaporative efficiency, chimneys and their function and effects. An important feature is the code of rules for conducting boiler tests, together with the results of numerous trials. This section is followed by one on steam engineering, in which horse-power is fully explained and its use made plain. Methods of testing steam engines are detailed and valve cut-off, proportions of cylinders for compound engines. The rules, or code, for steam engine testing are quoted in full,

and the interpretation of indicator cards, and heat analysis, has a place in this section. Steam pipe diameters and port areas are gone into in their various sizes and relationships. Main valves, link motions and condensers are also dealt with. Among locomotive data, formulas for resistances are given, including speed on grades and curves. The tractive power of locomotive and the powering of steamships are discussed. The steam turbine, with "trial figures," are given; also internal combustion motors, the gas engine diagram and rules for conducting gas and oil engine tests.

Under the head of electric power there are tables of various kinds, and some neat and very clear explanations of the equivalents and expressions of electric and mechanical data, and the many analogies between the flow of water and the "flow" of electricity. The National Electric Code, wiring formulas, electric standardization, electric driving, with data sheet on motor power and standard machine tools, are duly set down, together with remarks on electric cranes and motor tests.

The last section is devoted to cost of power. This gives data concerning water plant, costs of water power, steam power as shown by a series of exhaustive tests made with fuel burned directly under the boiler, and with the use of producer gas and with blast furnace heat. Cost of gas power and cost of electric power are indirectly compared. An appendix of forty pages is added in the latest edition of this book, here reviewed. It contains a variety of useful information on many engineering topics. This has been included in the index, and is thus part and parcel of the book. Altogether, the Mechanical Engineer's Reference Book is most fully, what it purports to be, a ready, useful and comprehensive collection of all kinds of data required, and most likely to be used, by a mechanical engineer in the practice of his profession.

The Theory of Heat Engines.—By Wm. Inchley, B.Sc., A.M.I.M.E., University College, Nottingham, Eng. Published by Longmans, Green and Company, London and New York; Canadian Selling Agents, Renouf Publishing Company, Montreal. 492 pages; 246 illustrations; size, 6 x 9 in. Price, $5.00.

This book is largely a treatise on the Thermodynamics of Heat Engines, although it also gives a few chapters on mechanics, in which it deals with balancing, governing, etc. Following the usual practice of most books along the same line, the author first gives the properties of the various working fluids, viz., gases, steam and other vapors, and then takes up the application of these fluids to the various engines, e.g., the steam engine, steam turbine, air-compressor, refrigerating machine, gas engine, etc. The work then takes up the practical testing of these machines and gives examples.

The first forty pages are devoted to the gases, and their application is given to air engines more for the sake of illustration, presumably, than for any practical value the latter engines have. Then follow 113 pages on steam and reciprocating steam engines, this whole important matter being fully dealt with in detail and various points illustrated by numerical examples. In this discussion, as well as elsewhere in the book, the author has freely used higher mathematics, and, indeed, it is difficult to see how one can develop any valuable solution of the heat engine problem without a working knowledge of the calculus.

Chapters dealing with refrigeration, the flow of steam in nozzles, etc., the theory of the steam turbine, of air-compressors and motors contain much useful and well-arranged material. The theory of gas and oil engines is fully treated, and a chapter is specially devoted to the variable specific heat theory. Some attempt has also been made to explain the methods of testing engines and boilers.

The last 100 pages, dealing with the mechanics of the engine, almost seem out of place, considering the general nature of the rest of the book, although objection cannot be made to them, because the information given is of value and belongs to the theory of heat engines. These chapters deal with valve gears, twisting moment diagrams, balancing and governors, and in parts of this, more especially the moment diagrams, the author has treated a subject analytically which essentially belongs to the province of the drafting board.

While the diagrams in the book are well drawn, probably some improvement would have resulted from a number of illustrations of actual machines. The general treatment is, however, excellent, but can only be read by men of good technical training.

PUBLICATIONS RECEIVED.

Winnipeg Electric Railway Company.—Annual report for the year ending December 31st, 1913, showing gross earnings of $4,078,694.75.

5,000 Facts About Canada.—1914 edition.—Compiled by Mr. Frank Yeigh and published by the Canadian Facts Publishing Company, Toronto.

Shawinigan Water and Power Company.—Annual report for 1913 showing gross revenue of $1,690,882.81, outlining extensions for plant, water conservation, development of Cedar Rapids, etc.

The Mineral Production of Canada, 1913.—A preliminary report, prepared by John McLeish, B.A., chief of the division of mineral resources and statistics, Mines Branch, Department of Mines, Ottawa.

Mineral Production of British Columbia, 1913.—Bulletin No. 1, 1914, of the British Columbia Bureau of Mines, a preliminary view and estimate compiled by Wm. Fleet Robertson, Provincial Mineralogist.

Brandon.—A 72 page booklet, descriptive of the city of Brandon, Man., outlining its possibilities as the railway and distributing centre, and containing many photographs of streets, buildings, industrial plants, etc.

Levels of Lake of the Woods.—Progress Report of the National Joint Commission on the question between Canada and the United States of the Levels of Lake of the Woods and its tributary waters and their future regulation and control.

Department of Public Works, Province of Ontario.—Annual report for the year ending October 31st, 1912, of the works under the control of the Public Works Department, comprising the reports of the deputy minister, architect engineer, superintendent, accountant, etc.

Fuel-Briquetting Investigations.—Bulletin No. 58, United States Bureau of Mines, outlining fuel-briquetting investigations since 1904; commercial aspects of the process; necessary equipment; costs; characteristics of briquets; tests; details of experiments, etc. 278 pages; illustrated.

Mineral Production of Canada during 1912.—Annual report of the Mines Branch, Department of Mines, compiled by John McLeish, B.A. The report covers metallic ores, non-metallic products, structural materials and clay products, besides a general summary of the mineral production and explanatory notes.

Effect of Smoke on Building Materials.—Bulletin No. 6, of the smoke investigation carried out by the Mellon Institute of Industrial Research and School of Specific Industries, University of Pittsburg. It contains chapters on the chemistry of soot and the corrosive products of combustion; the effect of smoke on exterior and interior paint coatings, stone, metals, etc.

Currents in the Gulf of St. Lawrence.—By W. Bell Dawson, Superintendent Tidal and Current Survey, Department of Naval Service, Ottawa. The report gives a descrip-

tion of the currents on the surface as a mariner may expect to find them in any locality; and an account of the general circulation of water in the gulf, together with the characteristics of its waters in regard to temperature, density, etc.

Report of the Minister of Lands, British Columbia.—The annual report for 1913 of the Minister of Lands of British Columbia contains the report of office statistics, of the Superintendent, of the pre-emption branch; of dry farming experimental work, and various other reports from government agents. The volume is well illustrated by maps and photographs, and comprises over 500 pages.

Investigations at James Bay during 1912.—Report to the Temiskaming and Northern Ontario Railway Commission by J. G. McMillan, supplemented by investigations during 1913. The report covers ice conditions and a character of channels in the Estuary of the Moose Jaw river; Reconnaissance of the south coast of James Bay; Navigation and Reconnaissance of the south coast of James Bay; Tides and Currents. The report also contains an account of Reconnaissance for the extension of the T. and N.O. Railway to James Bay by W. R. Maher.

The Mortar-making Qualities of Illinois Sands.—Bulletin No. 70, by C. C. Wiley, Department of Civil Engineering, University of Illinois, Urbana, Ill. Issued by the Engineering Instrument Station of that University. The bulletin discusses the effect of the characteristics of sand upon the quality of mortar. The results of a series of tests on thirty-two representative Illinois sands are given in tabular form and discussed. The classification of different sands is also proposed and specifications for each class are suggested.

Industrial Training and Technical Education.—Report of the Royal Commission. Part 1 forms the report of the Commission's opinions and recommendations. Part 2 covers such phrases of the study as elementary, secondary and higher education in relation to industrial training and technical education, manual training, household science, vocational education; industrial training and technical education in relation to national problems, needs, duties and rights of citizens, etc.; industrial research; education for rural communities. Part 3 contains the report of the Commission on inquiry in various countries, while Part 4 is devoted to details of the inquiry in the various Provinces of Canada.

CATALOGUES RECEIVED.

Small Direct Current Generators.—Bulletin A-4188, Canadian General Electric Company, Toronto, descriptive of type C. V. C. belted generator.

Steam Power Plants.—A 42-page illustrated catalogue describing some steam power plant installations. Issued by Lockwood, Greene and Company, Boston.

Small Motor Generator Sets.—Bulletin No. A-4190, descriptive of types M I C and M C C, Canadian General Electric Company, Toronto.

Chain Belt Power.—A handsomely illustrated 16-page catalogue descriptive of powers and equipment manufactured by the Chain Belt Company, Milwaukee, Wis.

Excavators.—A handsomely illustrated 16-page catalogue descriptive of the P. and H. Excavator. Issued by Pawling and Harnischfeger Company, Milwaukee, Wis.

Westinghouse Electric Fans.—Circular No. 165 of the Canadian Westinghouse Company, Limited, Hamilton, descriptive of the various types of fans offered for 1914.

Single-Phase Induction Motors.—Bulletin A-4185. Issued by the Canadian General Electric Company, being a general description of type K S motors and the field for their use.

Chicago Coal Drills.—Bulletin No. 150 of the Chicago Pneumatic Tool Company, illustrating and describing the Chicago Coal Drill for compressed air, electrical or hand-operation.

Electric Fans.— large 42-page illustrated catalogue of the Canadian General Electric Company containing descriptive information concerning style and rating, etc., of fans for various uses.

Mesta Improved Pickling Machines.—An 8-page illustrated catalogue descriptive of machine adapted for pickling metal objects of any shape. Issued by the Mesta Machine Company, Pittsburg.

Deferential Pump-Governor.—Ronald Trist and Company, Limited, London, E.C., have issued a cleverly gotten up catalogue on the "Thermo Feed" deferential pump-governor, its uses and working details.

Phenix Sight-Flow Indicator.—Bulletin No. 57 of the Richardson-Phenix Company, of Milwaukee, Wis., descriptive of device which may be inserted in water lines to indicate electrically any interruption of flow.

Wiring Devices.—Electrical supply catalogue of Factory Products, Limited, Toronto. 112 pages of details and prizes, of sockets, receptacles, plugs, fuse-blocks, clusters, outlet boxes, fuses, switches, cut-outs, cabinets, wall-boxes, etc.

Aluminium Low-tension Insulated Cables.—A 14-page pamphlet, issued by the British Aluminium Company, Limited, Toronto office, 60 Front Street West, being a reprint of an article in the Electric Review based on economical considerations.

Aluminium in the Construction of a Chemical Plant.—A 16-page catalogue, issued by the Toronto office of the British Aluminium Company, Limited, outlining economic possibilities offered by aluminium in its application to the plant and accessories of the chemical industry.

Cut-Off Valves.—The Lagonda Automatic Cut-Off Valves are described in the latest catalogue of the Lagonda Manufacturing Company, Springfield, Ohio. The catalogue also briefly describes water strainers, ball-bearing and thrust-bearing turbines for removal of scale, tube cutters and air or steam-driven cleaners.

Modern Methods of Heating, Ventilating, Sanitary and Electrical Design.—A 64 page pamphlet, published by the Canadian Domestic Engineering Company, Limited, Toronto, containing illustrations of installations and data descriptive of the engineering equipment in many recently constructed Canadian buildings.

Cranes.—Catalogue No. 26 of the Northern Engineering Works, Detroit, U.S.A., the Canadian branch of which is the Northern Crane Works, Walkerville, Ont. The catalogue illustrates electric and hand-power travelling cranes, electric and pneumatic hoists, bucket-handling and railway cranes. The catalogue is well illustrated and carefully condensed and occupies 64 pages.

Evershed's Electrical Instruments.—A 40-page catalogue descriptive of indicating and recording ammeters and volt meters, switchboard and portable types; indicate and recording leakage instruments, capacity meters, pyrometers, speed indicators, testing sets, etc., as manufactured by Evershed and Vignoles, Limited, London, E.C., for whom R. H. Nichols, Dineen Building, Toronto, is Canadian selling agent.

Structural Steel and Iron.—The Manitoba Bridge and Iron Works, Limited, have issued a 216-page cloth-bound catalogue descriptive of beams, girders, lintels, trusses, columns, stand-pipes, ornamental iron, highway bridges, steel tanks and towers, contractors' supplies, etc. The catalogue is specially arranged for the practical use of architects, builders, contractors, etc., and contains tables and notes on the application of structural steel and iron in modern building construction.

Coast to Coast

Galt, Ont. The Galt board of works has asked that $25,000 be placed to its credit to be expended in road improvements in 1914.

Toronto, Ont.—It is stated that by May the Timiskaming and Northern Ontario Railway's "Cobalt Special" will be composed of all steel equipment.

Victoria, B.C.—The engineering department of the city of Victoria has cut down its estimate on the local improvement work to be done in 1914 to about $425,000.

Newmarket, Ont.—Plenty of pure water is now being obtained from the 12 artesian wells supplying the town, and the flow amounts on an average to about 180,000 gallons per day.

Montreal, Que.—The Grand Trunk Pacific reports that work on the mountain section is proceeding day and night. There is a gap of some ninety miles to be filled up. This will be accomplished, it is believed, by the end of April.

Victoria, B.C.—The Victoria city council has approved the resolution forwarded to the mayor of Victoria by the mayor of Windsor, Ont., asking for the approval of the movement on foot to memorialize the Federal authorities to approve of the construction of a deep waterway from the Great Lakes to the Atlantic Ocean via the St. Lawrence River.

Calgary, Alta.—The first official train of the G.T.P. Calgary-Tofield branch has been pulled over the line from Mirror, the first divisional point west of Calgary. The road is pronounced to be in splendid running order, and a regular service will be inaugurated between Calgary and Edmonton as soon as spring opens.

Edmonton, Alta.—Last year the electric light department of Edmonton cleared a net profit of [illegible], or an approximate equivalent to 25 per cent. of the capital invested. As a consequence, the city council has a new light and power tariff; and a reduction will be made in light revenue of $32,000, in September change of $15,000, and in power revenue of $23,000.

Saanich, B.C.—The municipal council is taking action to restrain the Warren Construction Company from proceeding with work on the roads of the municipality. It is declared that the contract is invalid because the contemplated expenditure was beyond the municipal revenue for 1913, and that the city could not enter into the contract without a valid by-law for the provision of the money.

Vancouver, B.C.—It has been announced by J. G. Sullivan, chief engineer for the C.P.R., that approximately $20,000,000, exclusive of expenditure on terminals in Vancouver, will be spent in Western Canada in 1914. Of this amount, the larger portion will be required for the improvement work and double tracking proposed in British Columbia. However, new line to the extent of 600 miles is to be laid on the prairies; but the heaviest cost will be for the supply of rails and new ties.

Toronto, Ont.—The annual report for 1913 of the Hydro-Electric Commission was tabled in the Ontario House on March 16. A comparison was made showing the extent of the system at the end of 1913 and at the end of the previous year. The total annual expense for 1913 was given as $1,991,043, while for 1912 it was $1,377,168; the total revenue for 1913, $2,611,918, for 1912, $1,617,674; the net balance, or profits in excess of depreciation, in 1913, $390,395, and in 1912, $60,65[illegible]; and the total plant [illegible], while in 1912 it was [illegible].

Port Moody, B.C.—Preparations are being made by the Imperial Oil Company for the establishment of storage tanks and a refining plant on the north shore of Burrard Inlet, near Port Moody; and construction work will be started at an early date. The C.P.R. is ballasting the spur line from Port Moody, which was built last year, so that the steel and cement for the tanks can be transported to the site. The Imperial Oil Company acquired some time ago a 100-acre tract for its Western British Columbia base, and three large tanks, a number of small reservoirs for storing the different kinds of oil and a big machine plant will be established. A wharf 750 feet long will be built for berthing the ocean-going steamships which will bring the crude oil from California to the company's new works. The big tanks will have a storage capacity of 150,000 barrels. It is expected that the plant will be in operation within three months from the time construction work is started.

Minnedosa, Man.—On March 10, a conference was held at Minnedosa between representatives of the three private power companies on the Little Saskatchewan River, the council of Minnedosa, the superintendent of the Dominion water power branch and the assistant cheif engineer of the Manitoba hydrographic survey, regarding the power situation on the Little Saskatchewan River. It was explained that the Manitoba hydrographic survey had made a complete reconnaissance investigation of the power possibilities on the Little Saskatchewan, and also of the possibilities for the control and conservation of the river in the interests of the present and prospective powers on the river. The general result of these investigations indicated that a comprehensive system of control could possibly be worked out by utilizing the various lakes in the upper waters of the Little Saskatchewan and within the Riding Mountain forest reserve. The Department of the Interior has for some time been considering the best means of working out such a comprehensive control system, but desired to have a full discussion in the matter with the various private interests involved before taking any definite action. After some discussion, a resolution was unanimously passed expressing the approbation of the town of Minnedosa and the three power companies on the river in the work already done by the Manitoba hydrographic survey, and urging that it be supplemented by such further investigations as would be necessary to enable a final definite policy of conservation.

Montreal, Que.—The report of the improvements effected by the Montreal Harbor Commission in 1913 shows the completion of the Harbor Commissioners' railway line to high level from Molson's Creek to Tarte pier; the completion of 2 permanent transit sheds; an advancement almost to completion of the work on the drydock site, providing a large basin for the new floating drydock Duke of Connaught, and a large area of made land for the shipyard; the completion to the length of 2,000 feet of new quay walls of cribwork and concrete, and the partial completion of 2,000 additional feet; the construction of 4 miles of new railway track as well as the improvement and relaying of one mile; and the advancement of the removal of the artificial works at Moffatt's Island. Further, construction of a large industrial wharf at Pointe-aux-Trembles, and of two new transit sheds on the high level bulkhead wharves sections 24 and 25, was also started; a new electric hoist, with bridges connecting with the upper stories of the sheds on the Alexandra pier was built; new paving was laid on portions of the wharves; a start was made in substituting concrete for the superstructure of some of the old wooden piers in the central portion of the harbor, and additions and improvements were made to the various harbor plants. Elevator No. 2 and its connecting conveyer system to all berths in the central part of the harbor was operated during the whole season; and elevator No. 1 also worked satisfactorily, though an addition of one and a half times its storage capacity was being installed.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page , a directory of such societies and their chief officials.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

A meeting of the Electrical Section of the Canadian Society of Civil Engineers was held in Montreal on March 19th. Mr. Julian C. Smith was the speaker, and his subject was the performance of electrical insulators. It was followed by a good, general discussion, in which many prominent engineers took part.

Ottawa Branch.—A paper on "Structural Steel Design from a Commercial Standpoint" was read on March 19th before a good attendance of the members of the Ottawa Branch, by Mr. E. S. Mattice, of the Dominion Bridge Company, Montreal, and Mr. W. F. Gronau, of the Structural Engineering Company, Montreal. Mr. Mattice dealt with the practical side of the subject, and Mr. Gronau dwelt upon the theoretical.

Toronto Branch.—This evening (March 26th) Mr. J. G. G. Kerry, of Kerry and Chace, Limited, Toronto, will address the Toronto Branch on "The Proposed Terminal of the T. and N.O. Railway System on James Bay."

Victoria Branch.—On March 12th a paper on "Modern Guns" was read to the members by Captain N. C. Sherman, of the Pacific Coast Ordnance Department, and created a great deal of interest.

At the next meeting of this Branch Mr. H. W. E. Canavan will give an illustrated paper on "Modern Irrigation in British Columbia." This meeting is scheduled for April 9th.

ANNUAL MEETING OF S.L.S. ASSOCIATION.

The Saskatchewan Land Surveyors held their annual meeting at Regina a few weeks ago. The following officers were elected for the ensuing year: President, A. C. Garner, D.L.S., S.L.S.; vice-president, W. A. Begg, D.L.S., S.L.S.; secretary-treasurer, H. G. Phillips, S.L.S.. Counsellors—Messrs. W. R. Reilley, D. Alpine Smith, W. M. Stewart, Saskatoon, and J. A. Morrier, Prince Albert. Auditors—Messrs. E. C. Brown, G.T.P., and O. F. Cummins, Regina.

A number of interesting addresses were given during the course of the convention. The general discussion emphasized the need for raising the standard of the work of the profession, and considerable time was devoted to an investigation of the ways and means of best accomplishing this end.

Last year the association obtained legislation giving them complete control of the examinations and discipline of the members. In securing this advanced legislation the members felt that they had made great strides in raising the standard of the association, but it was felt that even better discipline could be obtained and more efficient work accomplished.

Mr. A. T. Thompson, S.L.S., of Grenfell, contributed to the programme by reading a paper on his "Reminiscences of the Early Days in the North-West," with notes on the Indian Tribes, which described his own personal experiences in this country during the last 30 years, and which was well received. Mr. Thompson was asked if he would contribute to the biography of the members, and he consented to do so.

On Monday the president, Mr. A. C. Garner, D.L.S., S.L.S., spoke of the most important matters to be considered, and gave a general outline of the work of the association. The secretary then presented his report and financial statement, showing that the membership has materially increased since the last annual meeting, and that all the members were taking an active interest in the work of the organization.

A very interesting paper was read by Mr. R. H. Montgomery, S.L.S., of the firm of Morrier and Montgomery, of Prince Albert, on "Practical Astronomy," dealing particularly with "Equation of Time." The paper was well conceived, and dealt with some very technical matters.

Mr. Stewart, S.L.S., of the firm of Phillips, Stewart and Lee, of Saskatoon, read a paper on the "Design and Construction of Open Ditches," pointing out particularly the drainage work done in this province and the machinery most suitable or this particular kind of work, taking into consideration the conditions of the soil and the size of the ditches required to be constructed. After giving his paper he was asked to furnish particulars as to this kind of machinery. He promised to obtain information regarding a plan which he believed would in time lessen the cost of construction of ditches. It was pointed out that difficulties which heretofore prevented a great deal of drainage work in this province were being removed, and that in the very near future an enormous amount of drainage work would be accomplished.

It was decided to have these papers printed and distributed for the use of the members of the association; also a statement of the association generally covering the four years that it has been in existence, including all other papers that have been read by members on former occasions.

THE PANAMA CANAL.

Over 100 graduates of the Faculty of Applied Science and Engineering of the University of Toronto were present at a meeting of the Engineering Alumni Association on March 23rd, when David A. Molitor, C.E., gave an illustrated lecture on the Panama Canal. Mr. Molitor, previously professor of Civil Engineering at Cornell University, was designing engineer on locks and dams in the Canal engineering organization. He is thoroughly conversant with the history of the present and earlier projects, as well as with the engineering features of both design and construction. His lecture was accompanied by the exhibition of about 100 lantern views, showing details of concrete and steel construction of the Gatun Dam and spillway, the locks at Gatun, Pedro Miguel and Miraflores, the methods of excavation at Culebra Cut, etc. A description of the construction and operation of the emergency dams which have recently been installed, and which Mr. Molitor designed, created considerable interest.

At the conclusion of the address the members took advantage of a good opportunity to ask questions and an extra half hour was spent in discussion.

In the absence of Mr. E. W. Oliver, the chairman of the Association, the chair was occupied by Mr. T. H. Hogg.

About the middle of April the Association will hold another meeting, which will be addressed by J. L. Weller, C.E., of St. Catharines, on the design and construction of the New Welland Ship Canal, of which project he is chief engineer.

EDMONTON ENGINEERING SOCIETY.

The Edmonton Engineering Society, of which Mr. A. W. Haddow is Secretary-Treasurer, hold meetings, at which papers are read and discussed, on the second and fourth Thursdays of the month.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Deven, 47 Slate Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

AMERICAN SOCIETY FOR TESTING MATERIALS —Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

PERSONALS.

VERNON C. LUCKNOW, consulting engineer, Victoria, B.C., is in Toronto this week in connection with the construction of the new Hudson Bay store building in the former city.

CHAS. CAMSELL, of the Geological Surveys Branch, Ottawa, recently addressed the Ottawa Field Naturalists' Club on the magnitude and navigability water-powers of the Mackenzie River.

FRED M. OSBORN, of Samuel Osborn and Co., Limited, Clyde Steel Works, Sheffield, England, has just completed a trip through Eastern Canada as the guest of A. E. Myles, manager of Heap and Partners, who are the Canadian representatives of Samuel Osborn and Company.

H. D. JOHNSON has joined the engineering staff of the Eugene F. Phillips Electrical Works, Limited, Montreal, as assistant contracting manager. Mr. Johnson, who is an authority on underground distribution systems, was previously with the Canadian British Insulated Company, Limited.

NELSON P. LEWIS, Chief Engineer, Board of Estimate and Apportionment, New York City, on March 9th delivered an illustrated lecture on "The Administration of Municipal Public Works" before the Graduate Students in Highway Engineering at Columbia University.

ERNEST BELANGER, of the firm of Marion and Marion, Montreal, has received an appointment from the Government of the French Republic. Mr. Belanger was a graduate of L'Ecole Polytechnic and a member of the Canadian Society of Civil Engineers, and of the Engineers' Club of Montreal. In his new position he will hold the title, "Officer of Public Instruction."

L. C. FRITCH, chief engineer of the Chicago Great-Western Railway, has been appointed assistant to the president of the Canadian Northern Railway. Mr. Fritch is a graduate of the University of Cincinnati, and entered railway service in 1884 on the Ohio and Mississippi Railway, of which he was later chief engineer. He was also with the Cincinnati and Deptford Railway as engineer in charge of construction, and division engineer of the Baltimore and Ohio South-Western. Later, he became assistant to the president of the Illinois Central.

Mr. Fritch will assume duties on April 1st. His head quarters will be in Toronto.

OBITUARY.

The death occurred last week of E. B. Temple, of Toronto, in his 77th year. Mr. Temple's career was largely devoted to engineering, and his work is well known to men of the profession throughout the Dominion. He took an active part in the construction of the Grand Trunk Railway between Montreal and Quebec, and upon its completion he joined the staff of the Canadian Pacific Railway at Toronto. A few years later he was placed in charge, by the Government, of harbor development and general waterfront construction work at Toronto, and it was under his direction that the walls and cribwork at the Eastern Gap were built.

Previous to his retirement from active work a year ago Mr. Temple was for 9 years harbor master at Port Arthur.

He was a member of the Canadian Society of Civil Engineers and of the Institution of Civil Engineers of Great Britain.

GEO. H. STREVEL, for many years a prominent Canadian railway contractor, died last week at Portage la Prairie at the age of 79 years.

BACK COPIES WANTED.

Copies of *The Canadian Engineer* for July 21st, 1910; November 3rd, 1910, and November 17th, 1910, are needed by a subscriber in order to complete a volume. Any reader who has one or more of these copies, and who will dispose of them, will confer a favor by communicating with the Editor.

ECONOMY IN HIGHWAY CONSTRUCTION.

Some interesting figures on the economical way of building highways are furnished by a prominent contractor, operating a system of portable railway in the highway construction work at Lockport, New York. They have about four miles of portable track, 40 cars, 36 x 24, and two 5-ton dinky locomotives. Most of this equipment is that of the Orenstein-Arthur Koppel Company of Pittsburg, Pa. The cars are hauled in trains of 12 cars each by one 5-ton dinky locomotive with an arrangement such that there is always one train of loaded cars on the way, one train of empties returning and one train of cars being loaded at the crusher.

The cost of operation is as follows:—

2 drivers' wages per day each $2.75	$ 5.50
2 brakemen (one for each train in transit) $1.75	3.50
Fuel and lubricating oil for two locomotives, and oil for all cars per day	8.00
2 brakemen for maintenance of track, one a foreman at $3 per day, and one at $1.75 per day, total	4.75
The above shows a total outlay for operation including a maintenance of track	$21.75

The amount of crushed stone carried in these cars is problematical, but the amount of stone actually in place spread and rolled and furnished with the equipment is 80 cu. yd. per day. The haul is three miles from quarry to road and, at the cost of $21.75 per day, equals 27 cents per cu. yd. for 3-mile haul—or 9 cents per cu. yd. mile.

The cost of laying portable track and grading up the shoulder of the road for this work will average between 2 and 3 cents per foot, this amount depending largely on the conditions of the road. If the road is of a clay substance, the cost will closely approximate the larger amount, but if the road is of a dry and sandy soil, the cost of laying the track, including grading, is not likely to exceed 2 cents per foot.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21474—March 10—Authorizing Cedars Rapids Manufacturing and Power Company to take additional 25 feet for right of way for transmission line, making in all a width of 125 feet, in parishes of St. Polycarpe and St. Ignace du Coteau du Lac.

21475—March 12—Directing that yard limit at Algonquin Park Station, Ont., be discontinued within 60 days from date of this Order. That if G.T.R. desire to discontinue use of locomotive whistle at station, it shall, within 20 days from date of this Order, file plans for approval of Board, showing a signal system to be established at Algonquin Park Station, and instructions as to operating same; such signal system to be operated either electrically or manually.

21476—March 11—Authorizing G.T.R. to use and operate bridge over viaduct, near Port Hope Station, Ontario.

21477—March 13—Authorizing C.P.R. to construct Lacombe-Easterly Branch of Calgary and Edmonton Ry. across highway on East Boundary of S.E. ¼ of Sec. 24-33-28, W. 3 M., Sask., at mileage 188.26.

21478—March 12—Authorizing G.T.R. to construct siding into the premises of Canadian Clarendon Marble Co., Limited, on Lot 879-80, town of St. Johns, Que.

21479—March 13—Authorizing, subject to terms of consent of Chas. Young, C.P.R. to construct spur for Canadian General Electric Co., Limited, on Subdivision, Lots 21, 22, 23, 24, 25 and 26, Block 69, city of Calgary Alta.

21480—March 13—Authorizing C.L.O. and W. Ry. (C.P.R.) to construct a business spur from a point on its main line at mileage 0 to a point in Lot No. 1 on N.W. corner of Ontario and Dundas Streets at mileage 1.11 (spur mileage), town of Trenton, Ont.

21481—March 13—Authorizing C.L.O. and W. Ry. to construct, by means of grade crossings, its business spur across C.N.O.R. main line and spur at mileages 0.47 and 0.74, town of Trenton, Ont., subject to and upon certain conditions.

21482—March 12—Approving diversion as constructed by C.L.O. and W. Ry. (C.P.R.) at mileage 91.18 from Glen Tay; and rescinding Order No. 18282, dated December 11, 1912.

21483—March 13—Approving location G.T.P. Branch Lines Co.'s station on Moose Jaw Northwest Branch, at Siding No. 11, in Sec. 26-22-6, W. 3 M., Sask., at mileage 63.

21484—March 14—Authorizing G.T.R. to connect its tracks with and to operate its engines, trains, and cars over siding recently constructed by Dominion Iron and Steel Company, at its premises at Point St. Charles, near Wellington Basin, in city of Montreal.

21485—March 13—Postponing cancellation of special mileage rates on grain for milling and export, as published in C.P.R. Supplement No. 3 to C.R.C. No. E-2715 and G.T.R. Co.'s Supplement No. 16 to C.R.C. No. E-2566, and 2, that special mileage rates, as published in Sec. 3 of C.P.R. Tariff C.R.C. No. E-2715, and Sec. 4 of G.T.R. Tariff, C.R.C. No. E-2566 be continued in effect for a period of one year from 20th day of March, 1914. 3. Leave be granted Rly. Cos., to make application to Board at end of such period, for a revision of the rates.

21486—March 13—Directing that G.T.R. install, within 90 days from date of this Order, improved automatic bell at crossing of highway immediately west of Lorne Park Station, Ont., thereafter maintain bell at own expense: 20 per cent. of cost of installing bell be paid out of Rly. Grade Crossing Fund, remainder by Railway Co.

21487—March 13—Authorizing C.P.R. to construct spur for Adolph Lumber Co. at Baynes Lake, B.C., from a point on Baynes Lake [illegible] E.K.D. B.C. Ry. Co., [illegible] spur [illegible] feet from crossing of Great Northern Ry. and connect it with [illegible]. Spur to be constructed within six months from date of this Order.

21488—March 16—Authorizing C.P.R. to construct road diversion under and across main line, Alta. Div. Aldersyde Sub- Div. in Sec. 5-14-23, W. 4 M., at Carmangay, Alberta.

21489—March 14—Authorizing C.P.R. to use and operate two bridges, namely, No. 62.8, Ont. Div., Windsor Sub. Div., and No. 79.1, Ont. Div., Windsor Sub. Div., Province of Ontario.

21490—March 14—Authorizing G.T.R. to operate over four bridges, No. 144 Trout Creek, St. Marys, Mileage 0.60; No. 90 Cull Drain, Blackwell, Mileage 161.40; No. 40, Stream, Tavistock,, Mileage 106.24, and No. 39, Stream, Tavistock, Mileage 104.01, all in Middle Div. 15th Dist., Ont.

21491—March 16—Approving plans showing location and details of freight shed and platform proposed to be constructed by G.T.R. at Prairie Siding, Ontario.

21492—March 16—Amending Order No. 20940, dated Dec. 3, 1913, by striking out figure "5" wherever it occurs in said Order and inserting therefor figures "25," so as to make same read, "Section 12, Tp. 25, Rge. 3, West of 4th Meridian?"

21493—March 17—Directing that C.P.R., within 60 days from date of this Order, install improved automatic bell at crossing of County Road No. 14, village of Hillsburg, Ont., and thereafter maintain bell at its own expense: 20 per cent. of cost of installing bell be paid out of "The Railway Grade Crossing Fund," remainder by Railway Company.

21494—March 16—Authorizing C.P.R. to construct spur for W. T. Williams and J. W. Davidson, Medicine Hat, Alta.

21495—March 17—Authorizing C.P.R. to construct Bassano Easterly Branch across highway between Secs. 5 and 6, Tp. 23-1, W. 4 M., Alberta, at mileage 112.47 of said Branch.

21496—March 17—Authorizing C.P.R. to construct Bassano Easterly Branch across highway between Secs. 25 and 26-21-6, W. 4 M., Alta., at mileage 83.6 of said Branch.

21497—March 16—Authorizing C.P.R. to construct spur to Newcastle Lumber Mills, at Newcastle, mileage 6.64 on Comox Extension of said Esquimalt and Nanaimo Railway, subject to certain conditions.

21498—March 17—Authorizing C.P.R. to re-construct bridge No. 109.36, on Mountain Subdivision, B.C. Division, B.C.

21499—March 17—Directing that on or before June 1st, 1914, the C.P.R. erect a shelter at Groverton, Ont., for the accommodation of passenger traffic.

21500—March 17—Approving revised location of C.P.R main line, as at present constructed, Thomson Sub. Div., from mileage 24.76, at Savona, to mileage 30, and from mileage 32 to 40.62, at Semlin, B.C.; and authorizing construction of an additional track (double track) on said revision; also authorizing, subject to an inspection by Dept. of Public Works for B.C., construction of said additional track across four (4) highways, from mileage 24.76 to mileage 30 and from mileage 32 to 40.62.

21501—March 16—Authorizing G.T.R. to construct bridge 266, at mileage 48.25, over Credit River, near Inglewood, Ontario.

21502—March 16—Authorizing G.T.R. to construct siding, commencing at a point on Northern Div. on Lot 3, Con. 1, Tp. Macauley, Dist. Muskoka, Ont., thence in southeasterly direction across Lot No. 3, and Lot No. 3 in 13th Con. Tp. Draper, and a public highway, into premises of I. C. McLeod.

21503—March 16—Authorizing G.T.R. to operate trains across bridge 130, over Nith River, at mileage 75.64, 17th Dist. near Princeton, Ontario.

21504—March 17—Authorizing G.T.R. to re-construct nine (9) bridges on 4th District of its railway, in Province of Quebec.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

ROYAL BANK BUILDING FOUNDATION WORK

TALLEST BUILDING IN BRITISH EMPIRE UNDER CONSTRUCTION IN TORONTO — GENERAL FOUNDATION SCHEME DESCRIBED—NOTES ON PIERS, COLUMN BASES, GRILLAGES, ETC.

THE steel frame building which is now in the course of erection on the northeast corner of King and Yonge Streets, Toronto, is in every way an extremely interesting undertaking. The structure has been designed upon the most up-to-date and modern lines, as regards both engineering and architectural practice. The intention of this article at the outset was to deal with the engineering features of the entire structure, but owing to its size and the extremely large amount of important matter which a complete description of it would involve, beyond giving a few particulars of a general nature only the foundations will be dealt with in the present article.

Fig. 1.—Showing Stage of Work on January 15th, 1914.

The building, which is to be known as the Royal Bank Building, will be twenty stories in height, which will give it the distinction of being the tallest building in the British Empire. The over-all dimensions will be 81 ft. 2½ in. on King Street, 112 ft. 2⅝ in. on Yonge Street, and approximately 273 ft. from sidewalk to roof. Fig. 8 shows the progress which has been made on the building up to March 20th. The ground plan is practically rectangular, with the exception of a light court which is introduced near the elevator shaft on the eastern side.

The basement is divided into three sections, that on the front, or King Street, being 14 ft. 7 in., the central portion 18 ft. 10 in. and the northern section 23 ft. 10 in. below the level of the sidewalk. The ground floor level over the whole area of the building is 4 ft. below the sidewalk.

Excavation.—The soil on this site is composed of an upper layer of clay extending to a depth of about 30 ft.,

directly beneath which lies a deposit of moderately hard and shaly clay for a depth of from 2 to 3 ft. Upon sinking through this (or to about 33 ft. below sidewalk level)

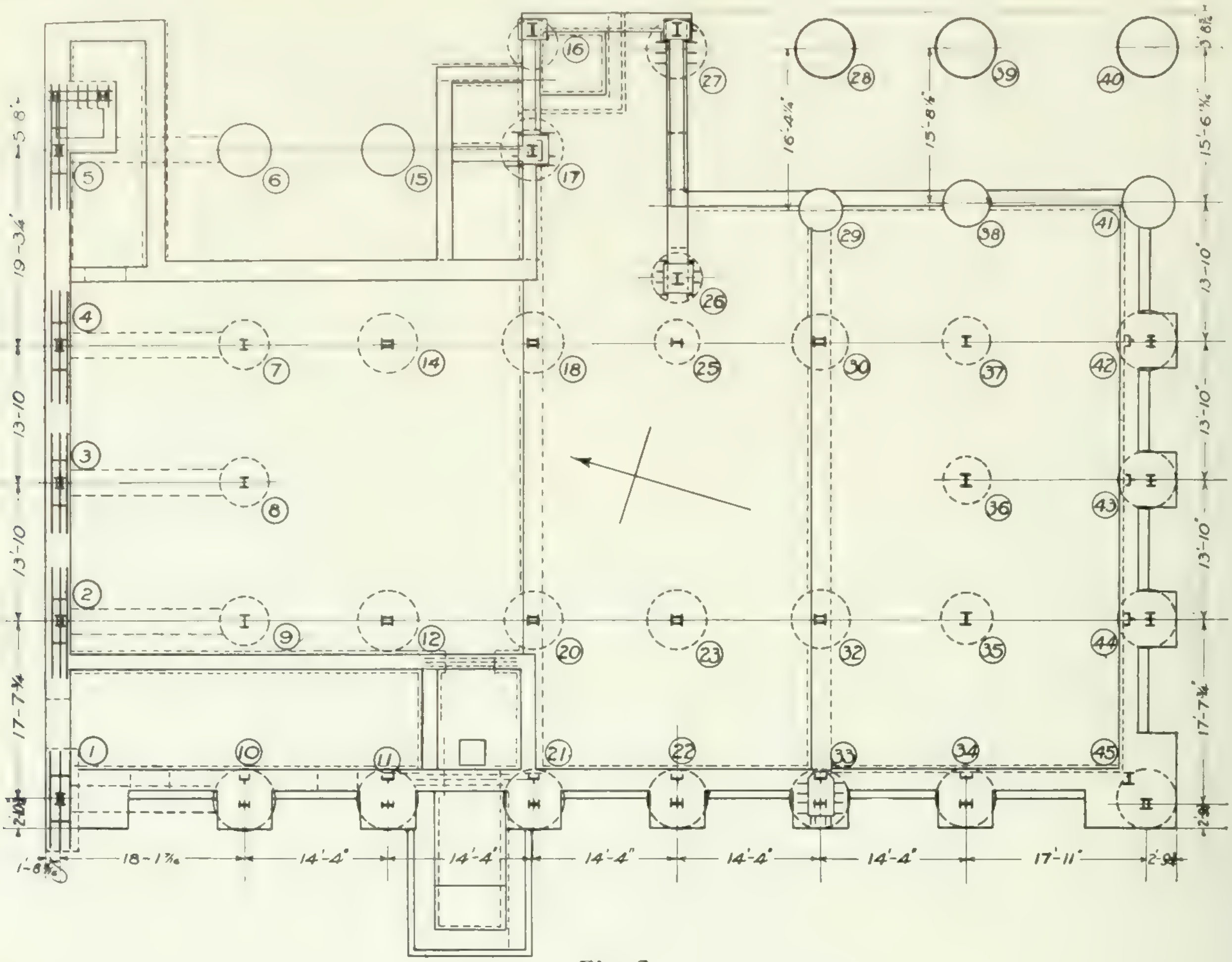

Fig. 2.

a very hard, dense shale is reached which, from borings that have been made in the vicinity, has not been found to change much in character in six hundred feet of depth, according to Professor Parks, of the department of geology, University of Toronto.

A test made on an isolated sample of this shale, in the testing laboratories of the University of Toronto, showed first signs of crushing when a load of 70 tons per square foot had been imposed. It is upon this hard shale of rock that the foundations of the building rest.

Caissons.—As no part of the basement is excavated down to the shale, caissons were sunk through the clay until bed rock was reached at each of the 41 points where a column foundation was required. Each column is carried upon a separate pier, with the exception of those which are carried on cantilever girders, or on plain girders, as shown on Fig. 2. All piers, with the exception of those along the extreme north end of the building, are circular in plan, and vary in diameter from 4 ft. 4 in. to 6 ft. 8 in. at the top, according to the proportion of the load that is transmitted to them.

These piers are increased in diameter at the bottom by an additional 2 feet in each case, the enlargement tapering through a height of 3 feet. On an average, each pier carries a load of about 14 tons per sq. ft. Owing to the nature of the soil, in sinking for piers it was found unnecessary to use any form of hollow caisson or piling as the clay walls were self-sustaining. Consequently these excavations were made exactly of the size and shape required, and on bottom being reached, were filled in with concrete to the requisite height to take the grillages. The concrete used was of a 1:2:4 mix, the stone being about 1½-in. gauge.

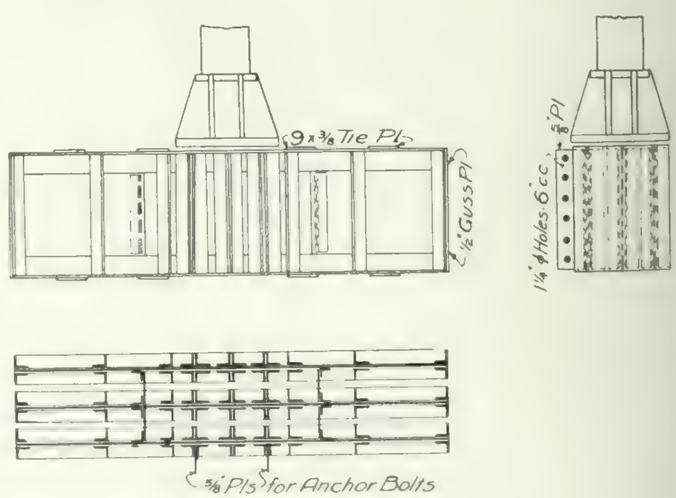

Fig. 3.

Grillages.—The grillages were composed of steel I-beams varying from 10 in. @ 30 lb. to 24 in. @ 100 lb., those for the main columns being composed of two sets of four 15-in. @ 50 lb. I's, and each set of 4 beams being

connected by means of ¾-in. through-bolts with pipe separators between the beams. One set was placed at right angles to, and above the other upon the concrete piers. They were carefully levelled up and the whole then

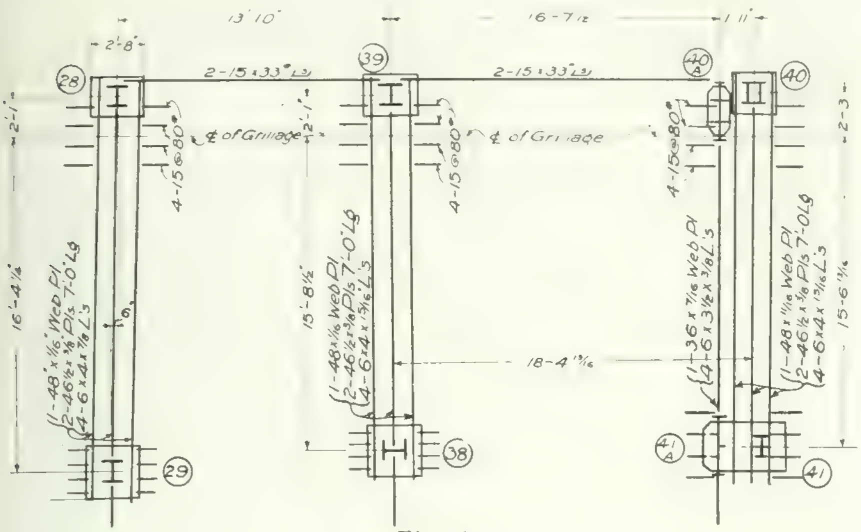

Fig. 4.

grouted in level with the top of the uppermost grillage. Section "A" of Fig. 5 illustrates the arrangement.

Column Bases.—Each of the piers constructed as above are capped with a heavy cast iron column base similar to those shown in Fig. 5. These bases were cast from tough grey iron. The actual test made on coupon bars one inch square in section and 12 in. long, loaded at the centre, gave on an average a breaking load of 30,000 lb. The upper surface of the cast iron bases is planed true and parallel to the lower surface, and holes are drilled for bolts to connect the columns to bases. In Fig. 1 several of these bases may be seen on the ground ready for placing. In designing these bases provision was made for 1 inch of grout between the base and the steel grillages. In setting, small wooden wedges were used under the corners of the castings, by which means the bases were set dead level, and raised or lowered to the exact elevation required. Grouting was then introduced through vertically cored holes at the centre of the casting, and by this means the space between grillage and base was thoroughly filled in. The wedges used in levelling were not removed, and, being of wood, will give under any compression to which they and the grouting may be subjected, thus insuring even distribution of the load over the whole surface without damage to the castings.

Type of Piers.—All piers are circular in plan with the exception of those under Columns 1, 2, 3, 4 and 5, along the north end of the building, and Columns 46 and 47, carrying a smoke stack at the north-east corner of the building. Columns 1 to 5 are each carried by ~~four~~ three plate girders bolted together as one, and running parallel to and under the north wall. (See Figs. 2, 3 and 5.) It should be mentioned that in the City of Toronto all building foundations must be within the limits of the particular building lot; footings cannot be carried out under an adjoining lot. Consequently it is sometimes necessary to cantilever out to place the columns sufficiently close to an adjoining wall. Owing, however, to the depth of the basement at this end of the building, bed rock is not more than 10 and 11 ft. below the column bases, and it was not necessary to use cantilever girders to carry these five columns. Instead, a trench was cut along the extreme northern limit of the lot, extending inwards about three feet, and downwards to bed rock. This trench was filled in with concrete to the requisite height, diagonal tie rods being inserted (as shown in Fig. 5) which later formed part of

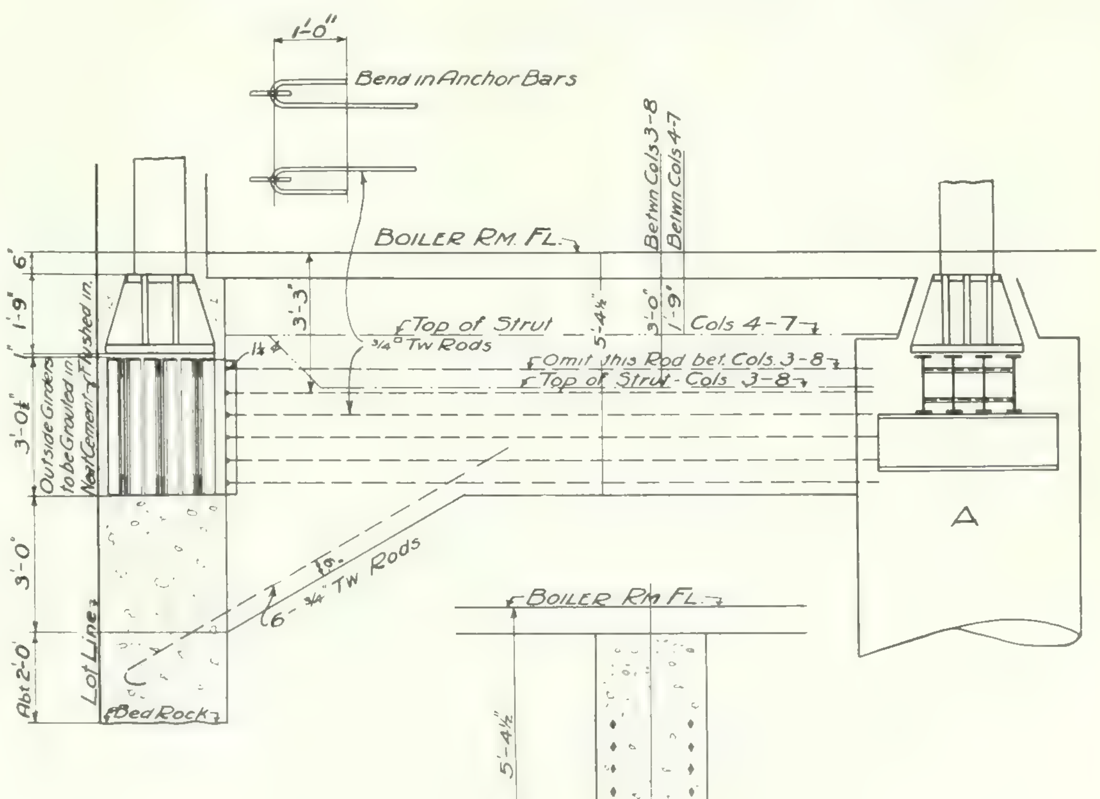

Fig. 5.

the horizontal reinforced concrete struts running at right angles to the girders. On this concrete wall were placed the plate girders already referred to. Twisted steel anchor rods were then hooked into the projecting plates provided on girders, and laid in a trench 2 ft. 6 in. wide

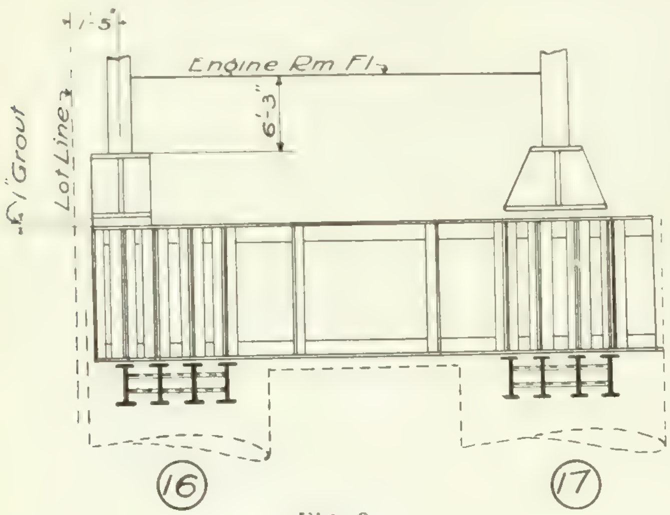

Fig. 6.

by 5 ft. 0 in. deep, extending out at right angles to the girders and butting onto the caissons of the next row of columns. The girders, and trench with rods, were then filled in with concrete, the outer girder being grouted with neat cement flushed in to lot limit, as shown in Fig. 5. The girders are surmounted by cast iron column bases levelled and grouted as previously described.

Columns Nos. 45 and 45a.—The foundations for columns Nos. 45 and 45a present several features which are worthy of special description. These columns are respectively the main and auxiliary columns at the southwest corner of the building.

The main column runs up to the full height of the building, but the auxiliary stops at the third floor level, and carries the wind bracing up to that point. Above the third floor the wind bracing is carried by the main column.

The pier for these columns is circular in plan, as shown in Fig. 9, and is surmounted by a special grillage composed of a bottom course of five and an upper course of six 12-in. @ 40 lb. I-beams, the latter course laid at right angles to the lower, as shown in Fig. 9. It will be noticed that the beams in the upper course are carried diagonally towards the centre of the building, to form a base for the auxiliary column. The weight thus applied would cause an eccentric loading upon the pier, the load centre approaching towards the inner wall of pier. To overcome this

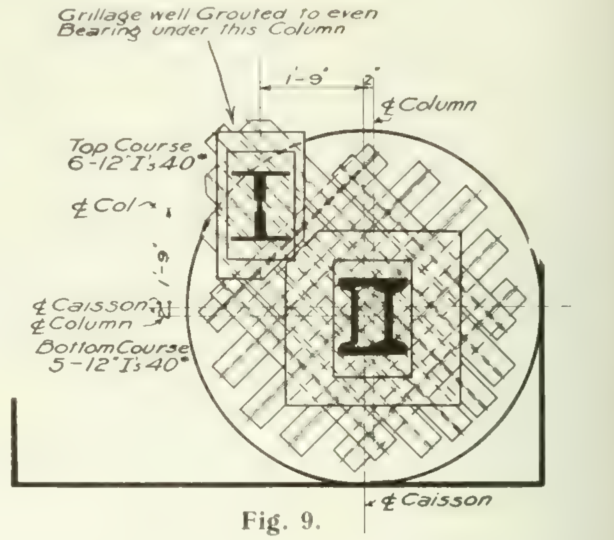

Fig. 9.

eccentricity of loading, the position of the pier has been moved diagonally inwards by 2¾ in., thus concentrating the combined load about the centre of the pier.

Cantilever Girders.—Columns 17, 27, 28, 39 and 40 on the east side of the building abut on an existing structure, and commence from a level considerably above the rock (as very little basement excavation was required under this portion of the building). They are carried upon cantilever girders. These girders are each carried in turn by two circular caissons which are surmounted by single grillages composed of four 15-in. I-beams. This is diagrammatically shown in Figs. 4, 6 and 7.

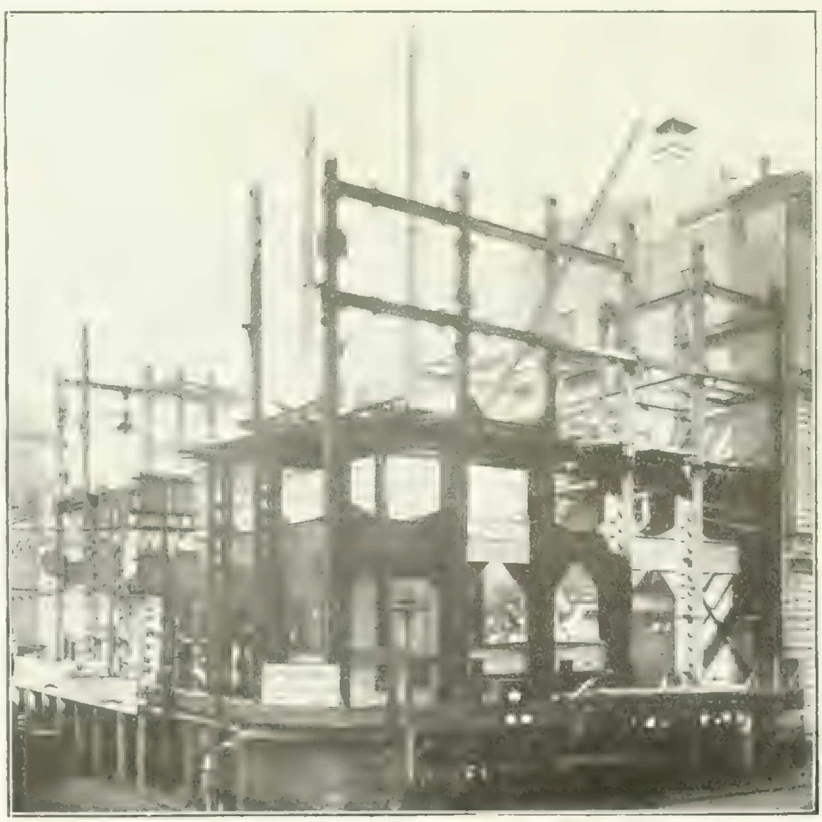

Fig. 8.—State of Erection of Royal Bank Building on March 20th, 1914.

The girders are each built in three longitudinal sections, as shown in Fig. 7, and are bolted together through diaphragms after being set in place. The spaces between the girders are filled with concrete, and they are also encased in the same material. A cast iron column base is set at both ends of each girder and grouted in, as shown in Fig. 6. This cut also shows the method of cantilevering.

The building is being erected for the Guardian Realty Company of Canada, Limited, at a cost of about

$1,250,000, including engineering and architectural fees and the carrying charges during construction. It will be managed and operated by Messrs. J. and L. M. Wood, Toronto, It is being built to the designs of Messrs. Ross and Macdonald, architects, Montreal and Toronto, to whom we are indebted for the photographs and drawings illustrating this description of foundation work. The whole of the steel-work for the building and foundations

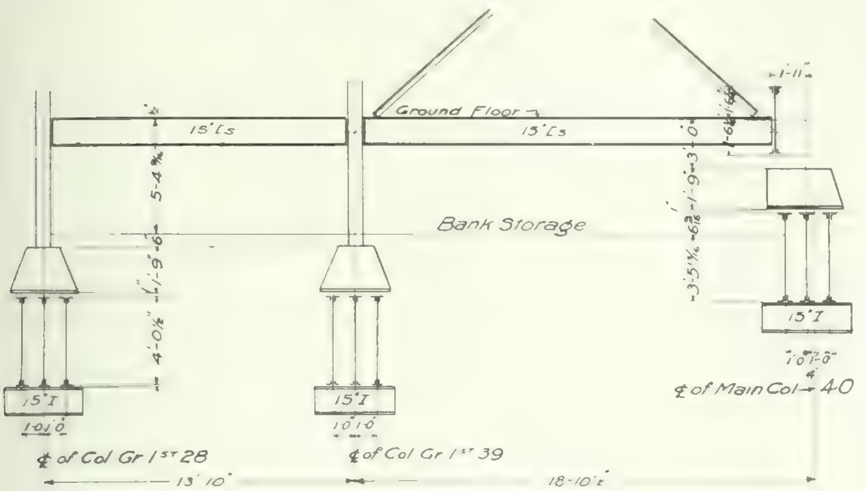

Fig. 7.

was designed by Messrs. Purdy and Henderson, Montreal. The steel is being supplied by the Dominion Bridge Company. Mill, shop and field inspection of all steel and testing of cement are being carried out by the Dominion Engineering and Inspection Company, Montreal and Toronto, to Mr. B. W. Seton of which firm we are indebted for much of the above information. The George A. Fuller Company, Limited, of New York, are the contractors and expect to have the building ready for occupancy in October next.

MOVING AN 8,000-TON BUILDING.

According to a recent article in the London Times an 8,000-ton three-story brick school building has been moved 1,650 ft. by placing it on a raft of timbers, cutting it loose from the supporting steel columns, hauling it across some sandy ground, four streets, and two street car lines, and turning it through an angle of nearly 180 deg.

The building rested on 60 steel columns, the heaviest load on an interior column being 135 tons and on an exterior column 160 tons. In preparing the building for the journey it was shored up on 12-in. by 12-in. timbers running under the floor-beams. The building is 142 ft. wide and 120 ft. deep. The columns are symmetrically spaced about the centre of the 142-ft. side, but are irregular in the other direction, which accounts for the uneven spacing of the 14-in. by 14-in. needles under the 12-in. by 12-in. cross timbers which were placed near the ends of each row of columns, even though there were only two columns in the row. Extra runs were placed near the end to take the extra wall load. As the footings for the steel columns extended below the ground surface into the basement the columns were cut off square about 4 ft. below the bottom of the floor-beams. Before removing the bases templets for the splices were applied and holes drilled in the portion above the cut, while prick marks were made on each footing. As the interior load was carried not by the cut-off columns, but by supports near it, 12-in. by 12-in. shores were placed on four sides of each column from the first floor to the second. On the shoring runways ½-in. by 6-in. steel plates were laid to receive the load from the 12-in. by 12-in. runners, 6-ft. long, under which were placed two similar steel plates turned up at the ends. There were 16 of these runners on each of the 19 runways and about 2,000 of the 3-in. steel rollers 2 ft. long. More than 1,500,000 ft. of 12-in. by 12-in. timber was used in the raft and shoring.

The blocking on the sandy ground rested on 6-in. by 8-in. ties laid close together with the material tamped under them as for a railway. Above these a blocking consisting of planed 4-in. by 10-in. timbers, and 6-in. by 8-in. or 6-in. by 6-in. cross-ties shimmed up to the bottom of the two 12-in. by 12-in. runway timbers, was used, the track plates being laid on the top of these last.

The pull was applied to six points at the rear of the building by 2-in. plough steel wire cables passed round the 14-in. by 14-in. timbers of the raft. Two loops in the centre permitted shackles to be attached at three points in the main cable. To these three shackles were attached triple blocks having seven strands of 1-in. wire rope leading 100-ft. away to the opposite blocks attached to a deadman. From the triple blocks a luff was made to double blocks, also attached to the same deadman, and a second luff, with a single block giving three strands of the 1-in. rope ending in a ⅝-in. cable, led to the drums of the hoisting engines used. The strain on the ⅝-in. cable was about one foot.

On the average the structure was moved 40 ft. each day, but the time actually spent each day in moving was only 30 minutes, the remainder of the time being taken up in carrying forward the runways and rigging the tackle and blocks. The building was moved a short distance and then turned slightly less than 90 deg. about the centre of the front wall as a pivot, after which the movement was in a diagonal line. It was again turned through almost a right angle, so that in its new position it faces in the same direction as before moving.

SLAG TAR MACADAM.

Slag tar macadam is a material very graphically described by its title. It consists of an improvement upon the early idea of tar macadam by the employment of a specially prepared furnace slag in the place of the usual road metal. In describing this product, it is stated that the metal consists of specially selected blast furnace slag, broken to standard gauges, mixed with selected tar and other ingredients, and specially treated for quick hardening by the com- [illegible] specially designed machinery, and stocked to mature. It is [illegible] nature and class of traffic, and the surface treated with fine [illegible] opening the road to traffic. After a period of from one to three months when the surface has become completely [illegible] little greater than that of an ordinary macadam road, whilst [illegible] slippery.

THE PROBLEM OF STREET CLEANING.

IT is not possible for anyone to give intelligent advice about the cleaning of the streets of any city without a pretty full knowledge of all the local conditions involved. The kind and state of repair of the pavements, the traffic to which they are subjected, the facilities for disposing of street sweepings and rubbish, the climatic peculiarities, the degree of cleanliness it is desired or expected to maintain, as well as numerous other local circumstances, are all elements that must be known and carefully considered in outlining a program for the street cleaning department. One attempting to write on the broad subject must, therefore, confine himself largely to principles and practices of general application. As an article of this nature much of instruction and value is contained in a paper appearing in a recent issue of *The American City*, and written by Mr. S. Whinery, Consulting Engineer, New York City. The article is as follows:—

In most cities the data on street cleaning afforded by local past experience and results afford the best basis for future projects and programs. While the methods followed and results obtained in other cities may be, and should be, studied, it must be kept constantly in mind that it is not wise or safe to base conclusions upon such data without a full knowledge and careful consideration of all the facts and conditions affecting them. This is particularly true of reported cost data, for in addition to differing physical conditions it is, unfortunately, true that the present methods of accounting in many street cleaning departments make it next to impossible to ascertain the actual or relative unit cost of the various details of the work, and to compare intelligently results in one city with those in another.

Finances.—In a project for cleaning the streets of any municipality, the first important practical step is to provide the necessary funds for the support of the street cleaning department. Other things being equal, the cost of cleaning the streets is, roughly, in direct ratio to the degree of cleanliness attained, and the amount appropriated will, therefore, control the quality of the work that can be accomplished. However careful, efficient and economical a street cleaning department may be, the quantity and quality of the work accomplished will be limited by the amount of money available for the work. It is illogical and unreasonable to expect a street cleaning department to keep the streets ideally clean when the amount of money allowed for the work is wholly inadequate to accomplish that result. Therefore, in considering the sum to be appropriated, the standard of cleanliness it is desired to attain should be first determined and the appropriation figured accordingly.

Money is required by the street cleaning department for two general purposes—the proper equipment of the department and operating expenses. The former is as necessary and important as the latter. Satisfactory results cannot be expected if the department is compelled to do its work with insufficient, antiquated and dilapidated apparatus. Every citizen engaged in conducting a private business enterprise appreciates the importance of procuring the best and most efficient machinery and appliances if he hopes to succeed in these days of sharp competition. He must be prepared to conduct his business and turn out his product at the lowest possible cost, and to do this his equipment must be up to date and the best of its kind. It is not unusual in large and successful industrial and manufacturing establishments that a comparatively new and costly machine will be discarded and scrapped, and replaced by an improved one that will turn out work at a lower cost, and thus prove more economical in the end. Few will deny the wisdom of the same policy in conducting municipal public work, and yet many street cleaning departments are compelled to get along with old, dilapidated and inefficient apparatus, and often not enough of even this is on hand to do the required work properly. It is wholly unreasonable to expect a department to accomplish satisfactory results either as to quality or cost of work under such conditions. Not only this, but it is, in the end, an inexcusable waste of the public money. It is a policy that may be truly called penny wise and pound foolish.

If expenses must be held down to a certain limit, it is wiser to curtail operating rather than equipment expenditures. In fact, the total expenses of the department may not infrequently be reduced by properly providing it with improved, efficient, labor-saving apparatus, even though the first cost may seem high.

While extravagance should be rigidly opposed, and while the financial condition of a city may make it necessary to restrict expenditures in all municipal departments, it must be borne in mind that if clean streets are desired or expected, the necessary money must be supplied to accomplish the purpose, and if this is withheld the street cleaning department should not be held responsible for the unsatisfactory condition of the streets caused thereby. Emphasis is here given to this matter of adequate appropriations, because in many cities where economy is felt to be necessary the street cleaning department is among the first to be attacked and to have its appropriations restricted or reduced.

Method of Cleaning.—It is coming to be generally recognized that from both the sanitary and business point of view the most objectionable part of street dirt is the fine dust produced by the drying out and pulverization of the animal excreta and other matter that finds its way to the surface of the streets. The fresh, raw and usually damp excreta and rubbish are objectionable mainly to the sight, but when dried and ground the dust floats in the air when disturbed, and disease germs contained in it are breathed into the nose, mouth and lungs of those exposed to it, where it may develop specific diseases. This dust, carried by the winds, enters residences and business houses to the injury of delicate goods or furnishings, and by reagitation may thence be carried into the human system. Any system of street cleaning that does not provide for the prevention or allaying of street dust cannot, therefore, be regarded as satisfactory. The best remedy against dust is to forestall its formation by removing the fresh material from the street as quickly and completely as possible before it can be converted into dust. Where the street surfaces are of such a character as to admit of it, the most effective method of accomplishing this is prompt removal of the accumulations by the so-called patrol system, where a limited area of street is frequently passed over by a patrolling cleaner and the fresh accumulations removed.

Sweeping by power sweepers at intervals of one or more days, while less expensive, is far less efficient and satisfactory, though if properly done and supplemented by sprinkling with water or oil at intervals sufficiently near together to prevent dust-flying, it serves a good purpose. But whatever method for primary cleaning is adopted, the formation of more or less fine material cannot be wholly prevented, and it is important that the street surface shall be frequently washed by the use of hose, flushing wagons or power squeegees. On well-paved city streets the most efficient and satisfactory method of cleaning so far devised, with the apparatus now available, is hand cleaning by the patrol system

during the day, followed by washing with hose or flushing wagons, or scrubbing squeegees during the night. While this is somewhat more expensive than plain machine sweeping, no other method yet devised will produce equally clean streets at a lower cost.

On macadam-surfaced streets this method is, of course, not applicable. With these, periodical removal of the loose material with hoes, brooms and shovels from street surface and gutters, and sprinkling in dry weather with water or oil to keep down the dust, is about the best that can be done.

Street Cleaning Apparatus.—The street cleaning apparatus now available and in general use is, as a rule, rather crude, inefficient and uneconomical. It may safely be said that street cleaning apparatus has not kept up with the march of improvement in other lines of work. The present machinery and devices may not admit of much further improvement, but there would seem to be a very promising field for the invention and introduction of new and perhaps novel devices that would do the work not only better, but more economically. The application of mechanical power to street cleaning machines and to conveyances for disposing of street waste has not made the progress that might reasonably be expected.

The disinclination of the average city council to supply the money to purchase and experiment with new and improved apparatus for the street cleaning department is doubtless largely responsible for present backward conditions. The wide-awake superintendent will keep his eyes open to possibilities in this direction, and the wise municipal government will give him authority and means to try out promising improvements.

The particular apparatus and devices most suitable for use in any city will depend materially on the local conditions, and must be selected with reference to these, and as the result of trial and experience.

Organization and Labor.—Assuming that the head of the street cleaning department is competent and knows from experience the local conditions and requirements, he should be given a free hand in the organization and manning of his department, unhampered by personal or political influence. This is a principle that has been discused so thoroughly and is so universally accepted in theory that it need not be enlarged upon here. Unfortunately, it is too frequently ignored in practice. If the head of the department is to be held responsible for results, as he should be, he must be given full authority in the selection of subordinates down to the laborers on the street.

It is the custom in many cities to make the street department a sort of asylum for those requiring charitable help. Unfortunates who, because of age, decrepitude, disease or other causes are no longer able to obtain employment in private concerns and must be, partly at least, supported by the public, as well as those who have become old and infirm in the city service, are forced upon or retained in the street departments with the idea that they can thus earn something toward their support and to that extent relieve the public of their care. It is a mistaken policy. Not only are these disabled laborers unable to earn the full wages usually paid them, but they are a demoralizing element in the whole labor force. The average laborer, however strong and capable he may be, reasons that he should not be required to do more work than those around him who receive the same pay, and will too often gauge his efforts accordingly. A few decrepit men, who are physically unable to do a fair day's work, may set the pace for a whole gang.

Where it is not possible to wholly segregate to themselves these old and infirm laborers, it will usually be far better and more economical to send them to some retreat, and to retire deserving, worn-out employees on a pension. Street cleaning work requires able-bodied, energetic, active and alert labor, and if men of that kind only are employed the whole force may be held up to a reasonably high standard of performance.

Disposal of Street Sweepings and Waste.—In most cities the final disposal of the sweepings and waste collected from the streets is a more or less troublesome problem, and the cost is no small item in the expenses of the street cleaning department. A few cities are able to dispose of a part of the sweepings from paved streets to farmers and gardeners in the near vicinity on terms that repay at least a part of the cost that would otherwise have to be incurred. But the expense of handling and transporting the material to any considerable distance, and its great bulk compared with its commercial value as a fertilizer, place a limit on its disposal in this way. Nevertheless, it should be possible, in the smaller cities at least, to interest farmers and gardeners in the use of this material to a greater extent than is now common, and to thus dispose of sweepings at a price that would reduce the cost of disposal otherwise. While the percentages of fertilizing elements in the sweepings even from smooth pavements are small, the actual market value, measured by the total quantity of these elements in a ton of sweepings, is seldom less than two dollars, and there ought, and doubtless sometime will be, some way devised to utilize or recover at least a part of this value. Mine tailings containing much less value per ton are profitably worked over and the value recovered, and it would seem possible that the less difficult and refractory street sweepings might, if the proper process could be discovered, be treated with equal success. It is a problem that deserves more study than seems heretofore to have been devoted to it.

The use of street refuse for filling low ground or reclaiming areas of shallow water and marshes has not received the systematic attention it deserves. If, where such lands are available, the city would acquire them by purchase to be gradually filled in with city waste, their value would in time be so greatly increased that the profits from their sale would go far toward paying the entire cost of waste disposal. This is not a random statement; there are instances where private persons or corporations, having contracts for the disposal of city waste, have made enormous profits by the intelligent application of this plan.

Too often cities are satisfied to obtain permission for the free dumping of such waste on private lands, the owners of which, in time, reap large profits therefrom.

There is, it is true, a feeling in the minds of the public that extensive dumps of street waste in the vicinity of built-up sections is not only insanitary, but may result in a public nuisance. Experience in a number of cities seems to prove that this prejudice is without foundation in fact. Dumps of street sweepings, if properly and intelligently handled, may be neither insanitary nor offensive. When spread in comparatively thin layers and in that condition exposed to the oxidizing effect of sun and air, the purest and richest street sweepings (free from garbage) will not create a nuisance.

Cost-Keeping and Accounting.—Until quite recent years little attention was given to accurate accounting and detail cost-keeping in the street cleaning departments of American cities. It was difficult, if not impossible, to ascertain from the records and books the unit cost of any particular detail of the work. Discussion and agitation have of late years led to great improvement in this respect in many cities.

It is coming to be more and more appreciated that in the present developed state of the business of street cleaning, improvements and economies must be looked for in more careful attention to details, and in the possibilities of small reductions in the unit cost of these details. To do this successfully requires a careful study and analysis of these details, including their fully itemized cost, which in turn requires a full and complete recording and accounting system.

It is desirable for many reasons that a uniform system of accounting for street cleaning departments should be worked out and generally adopted, but even were this done there would remain many exceptional details in each city, not covered by the general account, that require special study because of local conditions. While, therefore, an adequate general system of accounts should be adopted and maintained, a program for the collection, recording and analysis of such particular details or features of the work as may seem to have a bearing upon problems and conditions peculiar to that city should be mapped out at the beginning of the year and put in force. Any additional expense that this may involve is almost sure to be many times repaid by the increased efficiency and economy that a study of the results may make possible. What is here suggested is the application to the street cleaning department of the special detail investigations upon which the modern "efficiency studies" have been based and from which such important results have been in many cases attained.

PRODUCTION OF ASBESTOS IN QUEBEC.

Returns received from eight producers show an appreciable increase in the shipments of asbestos from the producing centres of Thetford, Black Lake and Danville, Quebec.

None of the East-Broughton properties were re-opened during the year; at Robertson, only one mine was in operation. The fibre of the East Broughton rock is short and its market value is low, but, on the other hand, the percentage of fibre recovered from the rock is high. The quality of the rock at Robertson stands intermediate between that of Thetford and of East Broughton.

There has been a marked improvement in the asbestos market, and although the conditions are not yet ideal, they are more satisfactory than they have been for several years. The working margin of profits in the asbestos industry is narrow. Taking last year's figures, the production, i.e., the asbestos extracted from the rock, totalled to a value of $3,578,007. This is of course allowing the same prices for the stock on hand as for the shipments sold. This value of asbestos was extracted from 2,527,410 tons of rock. It is true that 25 per cent. of this rock goes direct to the dump and is not treated in the mill, but nevertheless, all of it has to be quarried and hoisted to the surface from depths reaching over 200 feet. Therefore, at that rate, each ton of rock yielded $1.42 of asbestos. In 1912, this figure was $1.38 and in 1911, it was $1.53.

IRON IN QUEBEC PROVINCE.

The iron ore and iron smelting industry has been dormant in the province for over two years. There has been no production recorded since 1911, and the prospect for a resumption of activity is not of the brightest. The Canada Iron Corporation, which operated charcoal furnaces at Radnor and at Drummondville to treat the local bog iron ores, has placed its affairs in the hands of a receiver, pending a reorganization. The abolition of the government bounties on iron and steel is said to have been one of the main causes of this state of affairs.

Titaniferous iron ore, of which there was an output of 4,981 tons in 1913, comes from St. Urbain and from Ivry. It is used as an ore of titanium, of which element it contains from 18 to 30 per cent.

MANAGEMENT ENGINEERING APPLIED TO A HIGHWAY CONTRACTOR'S ORGANIZATION.*

By Henry B. Drowne,

Instructor in Highway Engineering, Columbia University; Engineer, Lane Construction Corporation.

THE fact that highway construction work looks simple and that only a relatively small amount of capital is required has led a large number of people to enter the field of highway contracting. Of this number some make a success, while others are a complete failure. Unfortunately, the law of the "survival of the fittest" does not always apply, because there are instances of those who survive through the medium of dishonest work. Competition in this line of work is very close. The big contractor with large plant equipment and heavy overhead charges must meet the competition of the small contractor who has plant enough to work only one job at a time and probably personally superintends the work. There is another class of contractors who make competition particularly discouraging at times by ignorantly bidding work at figures all out of proportion to the actual cost. This last class, however, is rapidly eliminated after trying to do work for which the bids have been too low. On account of the above conditions a contractor, who operates on a larger scale, must have a sound system of management or otherwise he will be forced out of business.

The writer believes that any man or association of men who desire to enter the field of contracting should first incorporate, as there are several advantages gained thereby. An incorporated company would usually have as officers a president, vice-president, treasurer, secretary and general manager. There might be a man for each office, or one man might occupy several of them, depending upon the size of the corporation.

No attempt will be made to outline in detail the duties of the individual officers of the corporation. Suffice it to say that at this point there should be two main divisions of duties into what might be called office work and field work. The office work would include all financial transactions of the company, such as obtaining credit, purchasing bonds, insurance, machinery and supplies and all accounting incident to the performance of the business of the company. The field work would include securing contracts and the planning and supervision of all construction work. The work pertaining to the first division is of a most important character and wise management and sound business in this department are in a large measure responsible for a company's success. On account of the brevity of this paper no further space will be devoted to this department. Consideration will be given to the management of the field work, that part of the work which is of more particular interest to engineers.

The generally recognized principles of good management are four in number and may be briefly stated as follows:—

1. The equal division of responsibility between the management and the workmen.

2. The development of a science for each element of the work.

*Presented before Section D of the American Association for the Advancement of Science at the Atlanta meeting, December, 1913.

3. The selection, training, teaching and developing of the workmen.

4. The co-operation of the management with the workmen.

Briefly stated, these rules may be applied as follows:

Usually the field work would be under the direct control of the general manager. A primary requisite to success is the ability to get contracts that will prove to be desirable work. It is difficult to make a poor job pay even under the best system of management, although an intelligent contractor will sometimes take one in order to keep his organization intact.

Second to securing desirable work would be the formation of the organization by means of which the construction work can be done. The building up of the field organization would be part of the duties of the general manager and its personnel is important. It is necessary to carry a permanent force that can be depended upon from year to year, this part of the organization comprising engineers, general superintendents, superintendents, foremen and skilled mechanics. The size of the permanent force would vary, depending upon the amount of work undertaken. In a progressive company the permanent force keeps growing proportionally to the increase in business.

The general manager should personally or through his immediate assistants, engineers or general superintendents, keep in close touch with each contract under construction. When a contract was secured, the machinery and tools necessary to do the work would be shipped to the job. Careful planning will save money that would otherwise have to be spent for new plant, as it frequently happens that some special machine can be worked to advantage on several jobs in the same season. The purchase of all material and supplies of any large amount would be done by those in charge of the office work, subject to the direction of those in charge of the field work. A superintendent, together with foremen and skilled mechanics would be selected to do the work and the approximate number of laborers necessary to start work would be determined upon. Questions arising relative to the interpretation of specifications, disputes with the party for whom the work is being done, estimating the amounts of work accomplished and the general planning of all the work would be attended to by either the general manager or his immediate assistants.

The foregoing shows to some extent the duties and responsibilities that would be assumed by the management. The superintendent who is assigned to carry out the plans on a contract would be selected on account of his fitness to do that particular job. Every man has his limitations, and it is the knowledge of these limitations that enables a successful manager to place a man where he will make good rather than to place him where he will be a failure. Besides being a man of energy and resource, a superintendent should be a man of good character. A contractor's reputation rests to a considerable extent in the hands of a superintendent and a reputable contractor values in no small degree his reputation for doing honest and thorough work. The superintendent would be responsible for carrying out the work pursuant to the plans laid down by his superiors. Delayed shipments, breakdowns, weather conditions, change of plans and labor troubles all combine to interfere with plans made in advance and the superintendent would often have to use his judgment in dealing with such occurrences until he can get in touch with those in charge of the field work. The co-operation of the superintendents, the foremen and skilled mechanics should always be sought in improvising methods to do the work in the most efficacious and economical manner.

The superintendent and his foreman should use considerable care in selecting laborers to perform different parts of the work and have considerable patience in training them to do it. An efficient gang can be developed only by a continual process of weeding out the poor laborers and the proper selection and training of those remaining. Fortunately many laborers consider highway construction as a sort of trade and they follow the same line of work year after year. If treated right they will seek employment with the same company each season, so there is generally a nucleus of experienced laborers available.

A good superintendent should always be cognizant of the cost of the work of each of his gangs and know whether the cost is out of proportion to the work that they are accomplishing. The gangs are never so large but that frequent inspection during the day and some mental calculation serves to show how work is progressing. Frequent visits by those in charge of field work would prevent slight errors on the part of the superintendent from becoming serious. Some companies require the superintendent to send to the office each night a daily report card showing the daily costs of doing the work. The writer believes that with a good class of superintendents who have the benefit of frequent conferences with those in charge of the field work the daily report card is not worth the trouble. The superintendent should, in any case, divide the work of the day under several classified heads which would be determined upon by those in charge. If a report of these classified costs for each day was sent into the office only weekly or even semi-monthly, it would prove to be efficient.

The fourth rule, that embodying the co-operation of the management and the workman, is particularly important to all highway contractors' organizations. Construction work of this kind only lasts two-thirds of a year, yet it is remarkable how a reputable contractor will maintain his permanent organization from year to year, even though his men are beyond his control for four months. The management must make the men feel that good and faithful work is appreciated and be quick to show it. Even the common laborer should not be forgotten. Although a bonus or other system of increased wages is rarely used by a highway contractor in dealing with his common laborers, the latter should be shown that those who excel gain the reward. Their efforts may be stimulated by seeing the cases of others of their class who are receiving increased pay or have been promoted to the position of foreman.

In concluding, the writer believes that the basic ideas contained in the principles of good management previously mentioned in this paper, are fully appreciated and are put into practice by the intelligent and successful contractors.

[illegible] gation engineers, the Lower Bari Doab Canal, the third section of the "triple canal project" in the Punjab, has just been completed, and is described thus in the engineering supplement of "The Times," London, England:—"The Lower Bari Doab Canal is unusual in construction, for it actually [illegible] an area equivalent to two-fifths of the whole cultivable area of Egypt. The great Punjab canals have done more, for they [illegible]

DOUBLING THE LOAD CAPACITY OF AN OLD IRON RAILROAD VIADUCT.*

By W. T. Curtis,
Contracting Engineer, Wisconsin Bridge and Iron Co.

In 1888 the Chicago and West Michigan Railway Company built a wrought iron single-track viaduct across the Manistee River, located about 100 miles north of the city of Grand Rapids, Mich., at a point now known as High Bridge, on the Pere Marquette Railroad, which system absorbed the old C. & W. M. Ry. some years ago. This viaduct is 1,170 ft. long, consisting in the main of 14 tower spans 75 ft. high by 30 ft. long, supporting 45-ft. spans between towers, and one 150-ft. river span across the main channel of the stream. The 30-ft. and the 45-ft. spans were, in the original construction, simple deck plate girders spaced 8 ft. on centres. The river span consisted of ordinary 150-ft. deck trusses spaced 14 ft. on centres. This structure as built 25 years ago, appeared as shown in Fig. 1.

During the winter of 1911-12, the structure was reinforced for heavier loading and stands to-day as appears in Fig. 2, taken from about the same point of view as Fig. 1. A comparison shows the reconstructed bridge to be somewhat more massive and substantial looking than the original. Fig. 3 is from a photograph taken at a little closer range after reconstruction, in order to bring out more clearly some of the details.

The original structure was designed for a loading about equal to Cooper's E-25. The rolling stock gradually became heavier and heavier, so that in later years the bridge was somewhat overloaded. In 1911 it was decided by the railway company to put still heavier loading (E-50) on the bridge, thus increasing it to an extent which would be unsafe for the old structure. It remained either to replace the structure with a new one, or to reinforce it, and the latter method was selected as being much more economical.

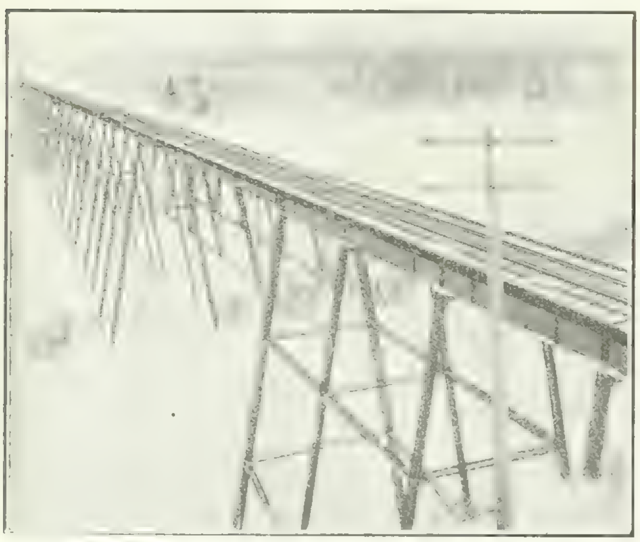

Fig. 1.—Viaduct Before Reinforcement.

Mr. J. F. Deimling, chief engineer, P. M. Ry., asked for competitive propositions for both cost and design on the reinforcement, submitting, by way of suggestive information, a solution which had been used some years ago on their Mill Creek trestle. This consisted of adding a new line of deck plate girders the entire length of the viaduct on the centre line of track, these girders being supported on new independent posts at the centre of each bent.

Some tenders were offered on this centre girder scheme of reinforcement for the entire Manistee viaduct, but were discarded, partly on account of greater cost but chiefly on account of uncertainty of distribution of load among the three girders, as the old girders of this Manistee viaduct are only 8 ft. centres, making the wood ties so short and stiff as to cause a marked degree of indeterminateness of the distribution of the load among the three girders. A further objection was the rocking or tipping effect over the new centre girder as a fulcrum under imperfectly adjusted or worn ties, the shortness of the ties magnifying this difficulty. (The girders of the old Mill Creek trestle were spaced further apart, which made the new middle girder idea less objectionable in that piece of work.) A still further objection to this centre girder scheme of reinforcement was the fact that the erection would seriously interfere with traffic during a long period of time.

Fig. 2.—Viaduct After Reinforcement.

Another scheme considered was to reinforce each of the old legs of the bents by adding another member parallel to it, surmounted with an additional new track girder placed closely along the side of the old girders, making a total of four girders with the old ones. This scheme was discarded as being prohibitively expensive, and somewhat unsightly as giving a pronounced appearance of being patched up.

The scheme finally adopted was proposed by the Wisconsin Bridge and Iron Company, being original with the writer, and is shown in Figs. 2 and 3, and also in diagram form, Fig. 4. The latter shows, in dotted lines, the old or original structure, and in full lines the newly added members.

This design was adopted for its economy, its lesser degree of indefiniteness of distribution of loads, its far greater general stiffness, its minimum interference with traffic during construction, and incidentally on account of its having a less patched-up and made-over appearance than either of the other schemes offered.

*From a paper to the Bridge and Structural Section of the Western Society of Civil Engineers, and appearing in the December Journal of the Society.

The governing or fundamental idea of the adopted scheme was to convert the upper or deck portion of the viaduct into a series of deep lattice trusses, of which the old girders would themselves constitute the top chords. This was done by adding a bottom chord about 12 ft. below the girders and introducing a Warren web system between the two chords thus formed. These old deck girders are, of course, stiff enough to resist the bending action of the load, and to deliver these local loads to the

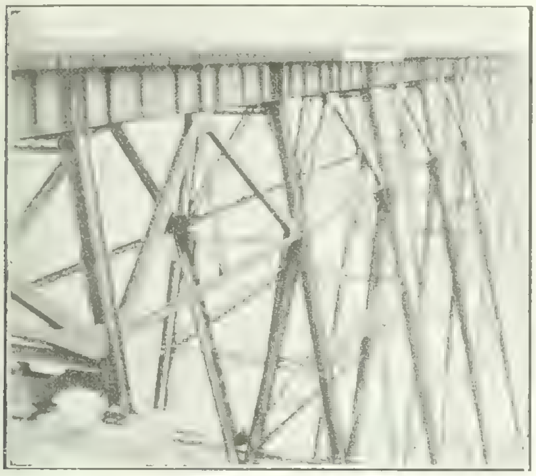

Fig. 3.—Detail of Reinforcement.

panel points of the newly formed truss. In calculation, for safety, the old girders were figured both as simple spans between new panel points, and as continuous girders, the worst result being used in all cases. Additional stiffeners were added and cross frames installed, as shown on Fig. 5.

pier built at the centre of each old bent. The two new columns thus form a V and make the remodelled bent consist of two A-frames, as shown in the typical cross-section sketch at the bottom of Fig. 4, and as shown quite clearly in perspective in Fig. 3.

This construction has the desired effect of virtually lessening the height of the trestle by about 12 ft., for the load is now delivered into the towers at the bottom chord of the newly formed trusses (Fig. 3). Furthermore, this system braces the structure longitudinally by virtue of the depth of the new trusses. Also, the new A-frame form of the bents stiffens the structure transversely. The scheme has the further advantage of being capable of field construction with practically no interference with traffic, as the old girders were not disturbed, except for the drilling of holes, etc., in them.

In this manner we preserved for the main length of the viaduct the original two-point bearing for the ties, which is undoubtedly the best, giving absolute definiteness of load delivery, and doing away with the tendency to tipping or teetering of the ties.

At the river span the system just described could, of course, not be followed, and here a new deck truss 150 ft. long was placed midway between the old trusses. The distance between the old trusses is 14 ft., being thus sufficiently far apart to give longer and consequently more limber ties, permitting of more definite proportioning of loads as delivered from the ties into the two old and the one new trusses, and also minimizing the tipping effect of the ties. In fact, this appeared to be the only reasonable solution of the river span problem, and was the one contemplated in all proposals offered.

The load from the new centre river truss is carried to the ground by a new independent straight column, as shown in Fig. 2.

The towers supporting the river span, and the three short spans of the north approach to the river span,

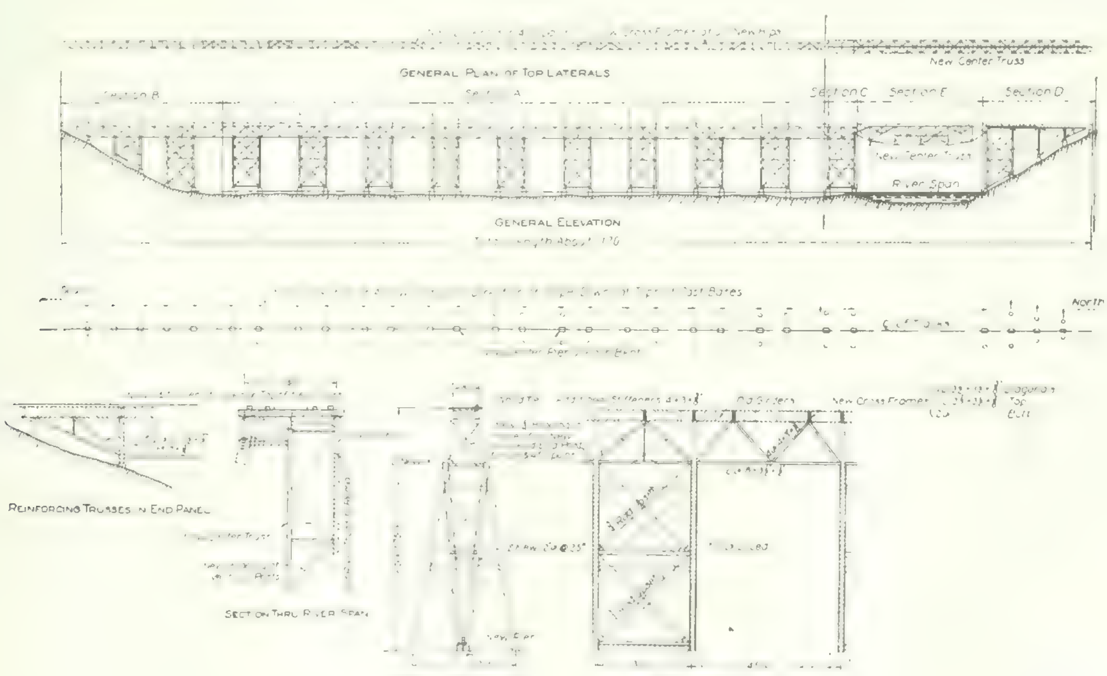

Fig. 4.—Elevation and Section Details of Bridge Before and After Reinforcement.

To carry the excess load from these newly formed trusses to the ground, two new columns are added to each bent, starting at the bottom chord of the new trusses and running on an incline down to a new concrete

were originally built with the deck girders spaced 14 ft. centres, the same as the river span trusses, and we therefore reinforced this small portion of the viaduct after the manner of the old Mill Creek trestle, i.e., by

the introduction of a new girder midway between the two old ones, in line with the new river truss and, like the latter, supported by a single new independent straight column at the middle of the old bents.

The new steel was figured as closely as possible in accordance with the American Railway Engineering Association specifications. The old metal, which is of iron, was figured in general at 14,000 lb. per sq. in. in tension, and at 16,000 — 70 l/r in compression. Judgment had to be exercised at all times in the application of specifications, this particular piece of work being most highly susceptible for the practical adaptation of that familiar remark which appears on the front cover page of all of Mr. Theodore Cooper's specifications, reading as follows: "The most perfect system of rules to insure success must be interpreted upon the broad grounds of professional intelligence and common sense."

In a remodelling work of this kind it is impossible to escape entirely, indeterminate features, as the engineer is confronted and restricted by conditions as they exist. He necessarily lacks the freedom of ingenuity offered on new work. The problem before us was to double the capacity of the structure, and the general aim throughout was to arrange the new parts so that the old parts would still carry their full share of the old E-25 loading, and so that the new members would make up the difference to bring it up to E-50, with sufficient excess to insure taking care of uncertainties.

One source of indeterminateness which was true of both of the schemes seriously considered was the possibility of improper distribution of load between the two old and the one new piers of each bent. This is always true in the case of a continuous three-point bearing, but there was no alternative in this problem, as there seemed to be no other way of getting sufficient bearing in the soil than to introduce the new middle pier. As a partial insurance to a proper distribution of loads on the three piers, the new middle pier was surmounted with an adjustable cast iron base, so simple in its adjustment that a bridge inspector on his annual inspection can, without any assistance whatever, and with no other tools than a good-sized wrench, adjust this shoe to take care of any difference in shrinkage or settlement which may appear among the three piers. The sliding surfaces of these adjustable shoes were coated with a cheap and lasting form of lubricant. The wedges provide for a vertical movement of ⅛ in. for a horizontal movement of 3 in. and are controlled by ordinary machine bolts with double nuts. In erecting the wedges, they were set in pairs with the slopes in opposite directions so as to neutralize each other and prevent the entire structure from tending to drift or slide all in one direction.

In Fig. 5 is shown sectional views of the cross frames and hangers between the two old river trusses and the new truss, the latter being somewhat deeper than the old ones. The heavy I-beam shown at the top of the new centre truss does not constitute a part of the top chord section proper, it being merely a continuous filler and tie support, in order not to permanently disturb the old top lateral system which was left intact. An entirely new lateral system was added below the old system in the plane of the new top chord. The old laterals are allowed to pass through holes in the web of this 15-in. I-beam, only one of the old lateral members being disconnected at a time to insert through this beam, and none being disconnected until the new lateral system directly beneath it was in place. This filler beam was provided with shims for adjusting it to fit the old ties.

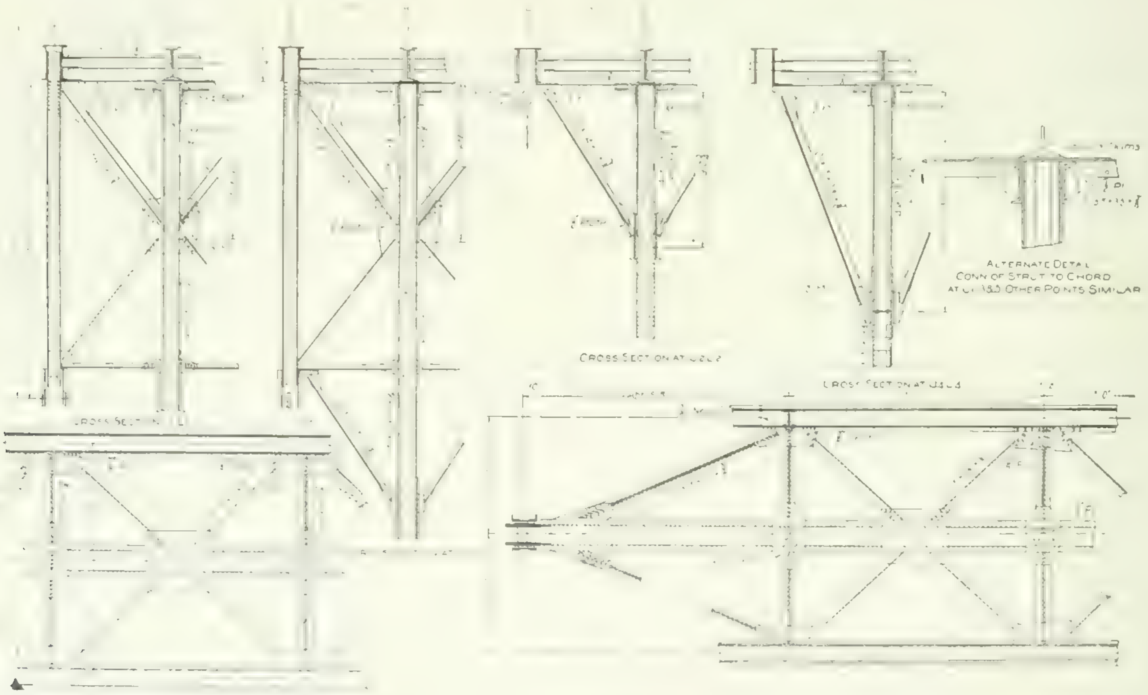

Fig. 5.—Cross Frames and Hangers Between Old and New Trusses.

A difficulty which presented itself was the difference in deflection between the old shallow river trusses and the new deeper one. This was studied carefully, and the difference in deflection was found to be sufficiently small so that it could be taken care of, to all practical purposes, by making the hangers from the old to the new trusses heavier than was theoretically required. This made the hangers act as equalizers, whereby if one truss should commence to be overstrained it would deflect enough more to deliver the load to the other truss before any actual harm would be done to the former. In this way, the load in any possibly overstrained member would

still be so much below the elastic limit load that set deformation was out of the question. It was found that the percentage of overstrain necessary to demand equalization was very low, and that while perhaps this solution of the distribution of the loads would not be considered as the most desirable practice in new designing, it served as a safe and satisfactory solution of the problem at hand.

The expansion of this new centre river truss was taken care of by a link construction, shown on Fig. 6.

The structure being narrow and high, the matter of thoroughly bracing it was nearly as important as the direct loading feature, and while the general form of reinforcement provided for a marked general stiffening of the main run of the viaduct, additional bracing was added entirely independent of the old bracing system, the old system being allowed to remain intact so that both systems are now acting jointly to withstand wind and tractive forces.

and the tractive forces are carried from this point to the ground by an entirely new system of bracing in the longitudinal plane of the legs of these new V columns. (This is shown in typical side elevation, Fig. 4.)

The solution of the more general problems, while interesting, led incidentally to problems of more minute detail, which were in themselves fully as interesting as the larger problems, and in some instances were fully as important. The detail drawings for the reinforcement of this bridge covered some 35 sheets, and the scope of this paper will permit of touching upon only a few of the more interesting details.

The new V shaped columns in the tower bents are designed to go half on either side of the old bents straddle fashion, and were shipped "knock down," each leg of the V being in two parts for each of its sections. The lacing bars were shipped riveted to one side of each section, the other side being connected in the field. It took careful drafting to insure no interference between the lacing bars of these new members and the old steel work. These new columns were connected to the old tower struts, where convenient, to form a general stiffening to the structure. In the erection of all these new columns the old steel was not disturbed, except for the necessary drilling. This, in fact, was considered as one of the commendable features of the design.

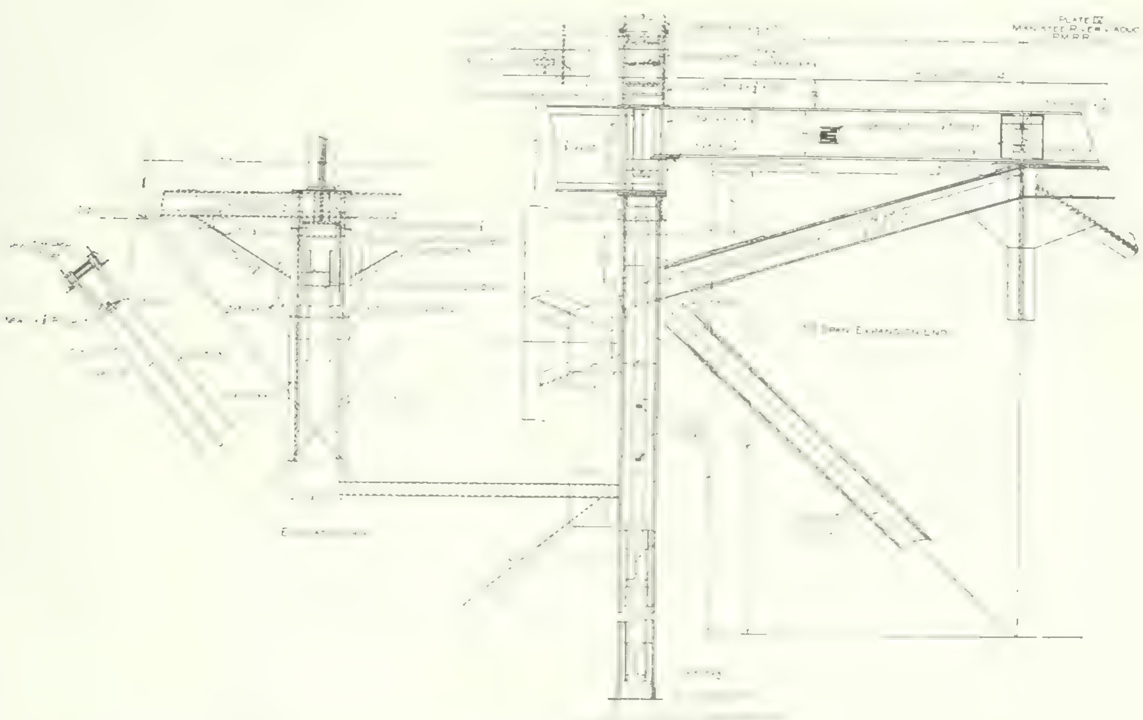

Fig. 6.—Provision for Expansion in Centre River Truss by Link Construction.

For the transverse or wind strains in the 45-ft. spans, new laterals are introduced for the middle panel of the newly formed trusses. (See Fig. 4.) These laterals terminate at new cross frames introduced at the panel points of the trusses carrying the wind load down to the bottom chord of the old deck girders, from which the load travels through a system of rod bracing in the plane of the inclined end posts of the new deep trusses to the tops of the newly formed A-frame columns. From this point to the ground the A-frames themselves constitute the additional wind or transverse bracing. The 30-ft. spans were similarly treated.

For the wind strain in the river and short approach spans which have the new independent straight centre column instead of the V shaped columns, no additional stiffness was afforded by the new column, and the old system of rods was therefore doubled.

For tractive force or longitudinal bracing the newly formed Warren side trusses formed sufficient bracing down to the tops of the newly added V shaped columns,

Connections for the rod bracing between the pairs of reinforcement trusses in the plane of the inclined end posts of these trusses presented a problem which was solved by the use of cast steel hitch brackets, which did away with what would otherwise have been clumsy and fussy detail. One of these hitch brackets is shown in position at the left-hand end of Fig. 7. In order to avoid the uncertainty of rivets in tension on these hitch brackets, bolts instead of rivets were used in the outermost holes. These hitch brackets were cut with right and left threads, permitting of direct adjustment of the tension rods.

Much trouble was experienced in finding suitable connections of the new wind-bracing rods to the old bents, which were not converted into the double A-frame form, on account of the old bracing being pin connected. Whenever possible, a connection was made, obviating the necessity of removing the old pins, but this was impossible in some cases.

Particular care was exercised to see that the loads from the new intermediate river truss were delivered properly into the columns, and a somewhat complicated detail resulted, as shown in Fig. 6, from which it will be observed that the details are so made, in nearly every case, that the old steel is not interfered with. This, in fact, was the aim of the detail work on the entire structure.

Extra care was exercised in all the details to allow for inconsistencies in the old construction. This was done by providing numerous shims and doing a great deal of field drilling that would otherwise not have been necessary. Fig. 7 shows details of the 45-ft. deep trusses under the old girders. In the upper right-hand corner of this drawing are shown shims and fillers which were provided to adjust the new steel work to the old. The entire job abounded in painstaking work of this character, in order that the new member would fit the old parts to which it should connect, and at the same time clear the old parts with which it was desired not to interfere. The detail drafting alone on this job cost a little over $950 for wages paid direct to the draftsman, exclusive of any overhead expense of any kind.

As previously mentioned, the foundations required reinforcing by the introduction of a new or third pier midway between the old piers, at each bent for the entire length of the viaduct. These piers were of concrete construction resting on piles, there being 12 piles to each of the standard bents, and 20 piles for the special piers under the new river truss. The piles were driven 35 ft. and were so arranged that they could be driven on either side of the old bent without disturbing the old iron work.

Considerable difficulty was encountered on this foundation work, due to the fact that there existed, unknown to the railway company or to the bridge company, an old corduroy road in the centre line of the viaduct for its entire length. This road was covered with several feet of sandy silt, which made it very difficult to remove the corduroy logs. In some cases the piles were driven right through the corduroy, in other cases the logs were removed, and in still other cases the logs were cut. One way seemed to be about as expensive as another.

Unexpected difficulty was also encountered on account of the water rising some two feet higher than had been previously known. This upset our calculations for cofferdams, causing much delay and expense.

The method of handling the pile driver was quite interesting. It had to be moved many times to drive the small cluster of piles at each of the bents, each cluster being split into two groups as divided by the old iron bents which stood on the centre line of each pile cluster. The pile driver was handled from the deck of the structure 75 ft. above, and was placed at the various points of operation without removing any of the old bracing. This not only saved expense but was better for the structure. The driver was picked up near its centre of gravity, tilted over with its legs uppermost and its nose or top thrust between the bracing rods of the structure to the desired point of setting up. In this way it was moved along from point to point. Very little timber bracing was used at the foot of the driver, which was guyed to the old iron columns of which there were plenty near each set-up. The engine was handled separately from the driver, not being mounted on it. This avoided the necessity of moving the engine as frequently as the driver.

The concrete was mixed and placed in the winter without any unusual expense, aside from the excavation and cofferdam annoyance previously mentioned. Gravel was brought to the site in hopper bottom cars and run out onto the viaduct to a desired point. A few track ties beneath the car were then spread and the contents dropped 75 ft. to the ice below. From the stock piles thus formed the gravel was conveyed over the ice to the final point of deposit, the mixing being done in each case right at the forms. The cofferdams were of the Wakefield type.

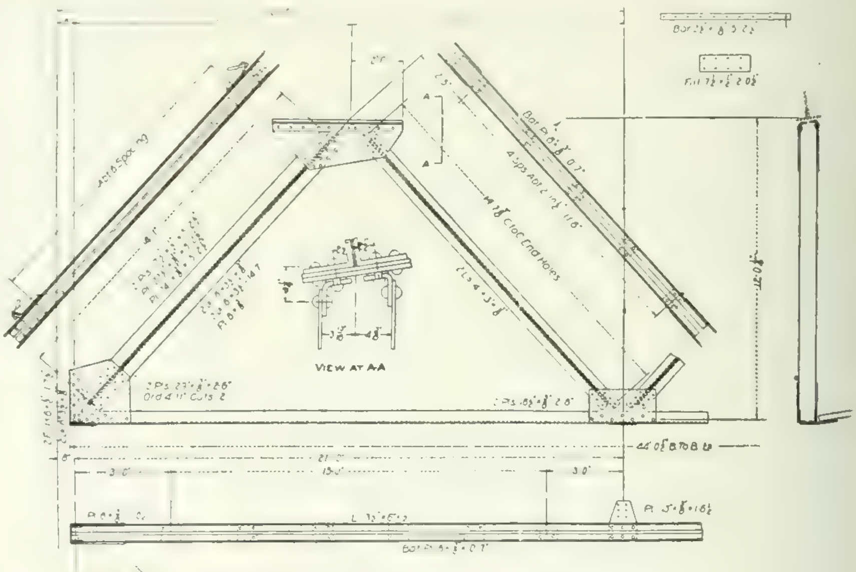

Fig. 7.—Showing Details of Trusses Placed Under Old Girders.

The weather was very cold most of the time, but we merely had to be sure that the frost was taken out of the dry material to begin with, for most of the concrete was placed under water and the small portion which protruded could be protected at slight expense with marsh grass and was kept slightly warm by the larger mass of concrete below the ice.

The erection of the steel work was somewhat unusual, and while at first appearing somewhat formidable, it worked out satisfactorily and with reasonable economy, barring delays due to foundation trouble.

The old work was mostly field bolted, which made the occasional temporary removing of old members less expensive. The field drilling and riveting was an expensive item, there being so much of it. There were about 7,000 holes to drill, about 2,000 old ¾-in. rivets to knock out and ream the old holes to 15 16 in., and about 28,700 rivets to drive on the job.

The new steel was handled by a derrick car at the beginning of the work, but this method did not prove

entirely satisfactory, and the derrick car was later replaced by a locomotive crane which gave better results.

The river span was erected with very little falsework. The new steel columns were first erected at the ends of this span. Then the top chord was raised and suspended from the old structure with steamboat ratchets, the turnbuckles being placed so as not to interfere with railroad traffic. All new top chord bracing was then placed, this being connected to the old trusses, and all bottom chord bracing removed. The balance of the new truss was then placed with falsework consisting of but a single wood post at either end, and the truss was kept suspended and controlled with 24 turnbuckles until completely riveted.

The work abounded in opportunities for interferences and misfits between old and new parts, but very little trouble in this direction was actually encountered—so little, in fact, that we were agreeably surprised, and considered this piece of work as a demonstration of the feasibility of doing this class of reconstruction at reasonable cost.

A word in regard to the condition of the old iron work may be of interest. Our erection foremen reported, early in the operation, that they found some old rivets which had to be removed; and some of the old laterals, etc., to which they had occasion to hitch stay chains, appeared to be harder and more brittle than they were accustomed to handling. This led to investigation, and a chemical and mechanical test was made on the upset stub end of a broken lateral rod, with the following observations:—

Sample A.

Manganese	0.05 %
Phosphorus	0.405%
Sulphur	0.020%
Silicon	0.289%
Area, sq. in.	0.1979
Elastic limit	not apparent
Ultimate strength, lb. per sq. in.	36,230
Elongation in 2 in.	3.5 %
Reduction of area	1.97 %
Fracture	Coarse crystalline

The above result of test was not satisfactory but the testing laboratory did not consider the sample a fair one as it appeared to have been subjected to abuse due to overloading in service, or possible burning in manufacture when upset.

Additional tests were therefore subsequently made of two samples cut elsewhere from load-carrying metal in the bridge, with the following observations, a mechanical test only being made in these cases:—

	Sample B.	Sample C.
Area, sq. in.	0.1979	0.1987
Elastic limit, lb. per sq. in.	41,230	42,300
Ultimate strength, lb. per sq. in.	50,500	57,520
Elongation in 2 in.	12%	16%
Reduction of area	12.2%	23.5%
Fracture	Fine granular	Half silky, half granular

While the metal in Sample B looked a little hard, the observations, taken as a whole, were such as to relieve suspicion as to the quality of fatigue of the iron in the old structure, and no further attention was paid to the matter other than a careful watching for defects, none of importance having been found.

As mentioned, the old structure was field-bolted (with the exception of buck and lateral bracing between the girders), a fact which was not discovered until after the field work of reconstruction had been begun. The owners, on becoming aware of this condition, at first seriously considered replacing all old field bolts with new rivets. Careful investigation showed the old structure to be in perfect alignment with none of the bolts loose in the slightest degree, although the structure had seen years of service and had been somewhat overloaded in its later years, so it was decided not to go to the extra expense of replacing the bolts with rivets. As a matter of fact, many of the buck and lateral connections which had been riveted originally, were found to be in bad shape on account of loose rivets, the vibration of passing trains having worn deeply into some of the rivets. While it was realized that the points which had been riveted in the old structure were points subject to more severe service than the points which had been bolted, the investigation satisfied all who participated in it that bolts are in reality much better than are generally considered in ordinary practice. Other observations we have had opportunity to make under somewhat similar circumstances have added evidence to this conclusion.

The cost of the reconstruction was, in round numbers, as follows; these figures including all extras on the work proper and a contractor's profit of 10%, the work having been undertaken on a percentage basis with a fixed maximum limit:—

Foundations in place (Ry. Co. furnished gravel free)	$10,200.00
New steel, 455 tons delivered at site (free freight)	22,400.00
Erection of steel (free transportation of men and equipment)	11,300.00
Total cost	$43,900.00

which, on a conservative guess, is only about half what a new structure would have cost.

The old structure weighed 496 tons.

INFLUENCE OF DRILLING HOLES ON THE STRENGTH OF SOFT STEELS.

Tests made at the Ecole Centrale, Paris, are reported in "Le Génie Civil" to show that when holes are drilled and then reamed in soft-steel bars the metal materially increases in strength, the average limit of elasticity improving 12.3 per cent. and the average tensile strength 9.2 per cent. This phenomenon is explained thus: In putting together the parts of a test piece broken under tension, it is found that the two ends do not coincide; and that, while the edges make a good contact, the central parts do not, thus indicating that the rupture begins at the centre, and that the edges have a higher tensile resistance than there is along the axis of the bar. Therefore, if several holes are drilled so as not to injure the material too much, as might be the case with punching, the average tensile strength of the section across the holes, per unit of metal, will be higher than before the holes were drilled, since each hole creates, so to speak, additional edges.

Westinghouse Church Kerr and Company, of Montreal and New York, [illegible] Railway as engineers to investigate the matter of the proposed [illegible] Tunnel in British Columbia. The investigations will cover in general the type of system to be installed, the relative economies of [illegible] fication upon operating conditions.

FLOW ON THE NORTH SASKATCHEWAN.

INQUIRIES received from some of our readers who are interested in the water power resources of the prairie provinces, respecting the stream flow on the North Saskatchewan River prompted us to apply to the Water Power Branch, Department of the Interior, for the information available at the present time.

It appears that there is a very meagre supply of data available as yet. In all, three gauging stations have been established upon the river. One of these was established in 1911 at Edmonton by the Irrigation Branch, Department of the Interior. It is stated that private interests have been taking records at Rocky Rapids, for which purpose a gauging station was established there last summer, but from this source no data are available at present. The records taken at Edmonton indicate fairly well the discharge to be expected at Rocky Rapids, as there are no streams of any magnitude entering the river between the two points; during the winter or low-water months the discharges of such streams would be negligible.

The low-water discharge has been known to fall as low as 1,200 cubic feet per second. The minimum recorded discharge is 1,073 cubic feet per second, which occurred Deember 4th, 1912, and is an actual metering. The maximum discharge recorded is 74,100 cubic feet per second, and occurred in July, 1912; though there is evidence upon which it is estimated that a maximum discharge of 180,000 cubic feet per second has occurred.

The following is the maximum, minimum and mean monthly flows recorded at Edmonton during 1911 and 1912:—

		Discharge in second-feet		
		Maximum.	Minimum.	Mean.
1911	May	21,755	6,508	9,238
	June	27,930	10,600	17,412
	July	51,442	15,520	28,094
	August	40,092	15,320	24,000
	September	18,668	8,024	11,502
	October	8,024	4,887	6,597
	November (1-10)	4,092	3,132	3,723
	December (6-31)	1,750	1,380	1,638
1912	January	1,402	1,164	1,255
	February	1,430	1,232	1,328
	March	2,620	1,062	1,316
	April	7,700	2,820	4,029
	May	16,200	4,770	11,926
	June	35,150	6,180	18,242
	July	74,100	15,000	13,900
	August	70,300	13,900	26,444
	September	23,750	7,350	12,864
	October	8,460	5,595	7,162
	November	5,595	1,504	3,177
	December	1,980	1,206	1,680

Some measurements taken in 1913 are given below:

	Discharge in sec.-ft.		Discharge in sec. ft.
January 17-18 ...	1,207	July 3	22,639
February 1	1,552	July 21	18,906
February 10	1,280	August 1	18,034
February 25	1,230	August 23	11,663
April 2	1,972	September 1	14,150
April 21	16,705	September 15	8,031
May 2	3,908	September 23	6,924
May 12	6,313	October 2	5,348
June 2-3	12,785	October 14	4,208
June 23	26,890	October 30	3,176

THE EXTENT OF MINERAL WASTE.

AN estimate of the present waste, in large measure unnecessary, of mineral resources in the country may be arrived at by a comparison with that of United States, which amounts to a loss of not less than $1,000,000 a day.

In one respect at least a consideration of the mineral wastes has a basis quite different from the consideration of agricultural wastes. Our crops represent an annual production from a reasonably permanent soil; our forests may grow again, though a much longer period of time is required; and the soils themselves may be reproduced from the subsoil and the rock beneath. But of our mineral resources we have only the one supply. This supply is to a considerable extent destroyed in use; and at the present increasing rate at which we are using and wasting it our one supply will be either exhausted or largely depleted while the country is yet in its youth.

The most urgent need for investigation and reform in the country to the south of us is in connection with the unnecessary waste of oil and natural gas. The United States Bureau of Mines reports that it has been able to stop a waste of natural gas during the past year valued at $10,000,000, with very limited facilities at its disposal. In many parts of the Oklahoma oil and gas fields the waste of natural gas that still continues is equivalent to $15,000,000 to $20,000,000 per annum, and this waste in all of the oil and gas fields of the country now aggregates more than $50,000,000 per annum. Of the total waste of gas in the different oil fields of the country more than 80 per cent. is believed to be easily preventable. As regards the remaining 20 per cent., it is believed that gasoline may be extracted from much of it and the gas itself burned for some useful purpose.

The need for enlarged investigation is further shown by the fact that in addition to this waste of gas the waste of petroleum, and especially the loss of the lighter oils, in pumping and storage is much greater than is ordinarily supposed. Moreover, the injury caused in a number of oil fields through the flooding of oil and gas strata by underground water is a separate phase of the subject calling urgently for inquiry and investigation.

The waste in coal mining is another drain which calls for serious inquiry and investigation. A preliminary estimate, based upon limited inquiry and examination, indicates an annual waste or loss of coal in mining and handling of not less than 250,000,000 tons per annum.

What is needed in connection with this loss is a thorough underground survey and examination at certain carefully selected areas in each of the important coal fields of the country, with a view to determining the exact conditions under which mining operations take place and the possibilities of adopting less wasteful methods.

There is a strong advocation of similar investigations looking to a reduction in the wastes or losses in the mining, preparation, and treatment of metalliferous ores and metals, which wastes and losses aggregate in different cases from 10 to 50 per cent. of the total yearly production of such minerals and metals.

Although the above figures apply to conditions in the United States, they sound a warning note everywhere against thoughtless waste in the eager regard for temporary gain on the part of individual operators. The saving already accomplished indicates the fruits awaiting similar methods to prevent the total and permanent losses which metal mining and metallurgical operations sometimes entail.

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CONTENTS OF THIS ISSUE.

FOR THE YOUNG ENGINEER.

The season is drawing to the stage when the portals of our universities will open for the young graduate to pass out into the field of engineering. In his eagerness for activity of a constructive nature he is not likely to pause for an invitation to lay aside his books. He should understand at the outset, however, that in spite of its qualified instructors, rigorous discipline, specialized courses and extensive equipment, the university does not turn him out a finished engineer. It has done well if it has fitted him with an understanding of how to acquire the technical knowledge which the problems of the profession will demand as they one by one present themselves.

At this time it is appropriate to bring before the young graduate some attributes of engineers and engineering that may not have appeared on the surface during the course of his academic work. One has only to observe a view of his surroundings in the course of the day to perceive what is being done and what is still to be done in the converting of forces and materials of nature to supply the needs of the world. The engineer is the man who leads and directs the doing of it. The work itself provides his best pay in the satisfaction of its successful accomplishment. Uniting the Atlantic and Pacific at Panama, throwing transcontinental railways across the Dominion, reclaiming vast areas through irrigation, developing water powers great and small, or driving tunnels through Mount Royal and the Rockies, exemplifies the efficient and capable manipulation of forces with which engineering has to do.

In his article on another page of this issue Mr. J. L. G. Stuart has paralleled the outstanding professions of the present day, with the result that the young engineer may be justly proud of his own selection. But it should be added that the unvarying forces and principles of the engineering profession require of him the same strict integrity and attention to business that spells success in any less advantageous choice of occupation. He will learn early that the engineering world has no place for other than the energetic man. His work is to get things done.

Further, he should aim to retrieve without delay the broadness of view which forced attention to special studies has required him for a certain lapse of time to forego.

Finally, as Mr. Stuart has intimated, engineering is a progressive profession, and the young engineer must resolve to keep up-to-date. A more intimate knowledge of his own particular branch of engineering should be his chief desire, but an equally important duty to himself is to keep posted upon what is being done in a general way along engineering lines. He will find that these requirements can be best attained by close relationship with men of his profession, through personal acquaintance, engineering societies and the engineering press.

ADVANCE IN ENGINEERING EDUCATION.

Next May the School of Mines of Columbia University will celebrate its 50th anniversary and it is stated that the curriculum which has been followed for a number of years without material change will then be discontinued. Under the new arrangement three years of specialized study in the various branches of engineering will be offered leading to the several technical degrees in the Schools of Mines, Engineering and Chemistry. The requirements for admission will be the completion of at least three years of college or scientific school training.

The reason for this change is undoubtedly the outcome of prevalent opinion that in recent years something more has been necessary for the well equipped engineer than a sound technical knowledge of his subject. The engineering profession enters into almost every walk of life and the engineer should be a man not only well versed in his profession, but a man of affairs. He is called upon for advice in subjects connected with engineering to-day that were never associated with it until the past few years. Instead of being called into consultation on technical subjects alone he is now expected to give information upon matters connected with the business world in a way the engineer of a few years ago never imagined. Instead of adhering strictly to science he must now pass upon problems connected with economics, finance, and politics, and must always hold his own in the councils of men of business.

That a high school boy who comes to an engineering school is handicapped under these circumstances cannot be doubted, and the new order of things now being established at Columbia University promises a measure of relief.

It is a course which our universities with faculties of applied science and engineering should consider very thoroughly. If the engineering student could possess the basis of a general college education when he enters it is bound to help him to attain the position now demanded of the engineer and he will be better prepared to take up the harder tasks of graduate work with no necessity for apprentice work.

The completion of at least three years of a college or scientific school course as now required by Columbia for admission, this course to include thorough instruction in mathematics, physics and chemistry, and in addition, preparatory work in draughting, shop-work, mineralogy and surveying, places the student in a position to efficiently assimilate the education which there is to be derived from the demonstration and personal operation of the equipment with which our university laboratories endeavor to combine the practical with the theoretical.

EDITORIAL COMMENT.

The citizens of Ottawa have voted in favor of mechanically filtered water from the Ottawa River in preference to the 31-Mile Lake scheme advocated by Sir Alex. Binnie.

* * * *

Previous reference has frequently been made in these columns to the work of the International Joint Commission, and to the efficient methods which it followed for the consideration and solution of the variety of problems submitted to it by the governments of Canada and the United States. On April 7th the Commission will meet in Washington to resume its consideration of the applications of the Michigan Northern Power Company and the Algoma Steel Corporation for authority to divert water and to build compensating works in the St. Mary's River at Sault Ste. Marie.

Since its meeting in Detroit early in March a committee consisting of engineers representative of both countries and of the two applicant companies, have been engaged in drafting a schedule of conditions designed to provide such regulation of the dam in the St. Mary's River as will effectually safeguard the interests of the municipalities and others at the western end of Lake Superior.

ENGINEERING AMONG OTHER PROFESSIONS.

By J. L. G. Stuart, B.A.Sc.,
Assistant Engineer, Roadways Department, City of Toronto.

THE engineering profession is a very progressive one. It is always looking into the future, always trying for something a little better than it has already accomplished, always attacking new problems and doing new and bigger things. This is to some extent true of the medical profession, but it can hardly be said to be true of law, for the lawyer is always looking to the past and hunting up an old precedent to govern the administration of justice to-day. If past decisions were in accordance with the eternal verities, and had proved themselves just, beyond dispute, it would be all right, but such is not the case, for these laws and decisions were merely man-made, and the only thing that keeps a great many of the decisions standing is that they have not been carried to a higher court. In engineering, the fact that such a thing was done in such a way last year, last decade or last century, rather counts against that way of doing it to-day, for it is almost certain that there is a better way of doing it. The whole tendency of law and theology is conservative, that of engineering is progressive. In five years an engineer is almost out of date unless he has striven to keep abreast. Not so the clergyman, while a lawyer has simply to read up the last five years' statutes and decisions.

In engineering, probably more than in any other profession, a man has to stand on his own ability to do things. Fine words and fine manners do not count; it is his works that speak. In medicine, law and theology a man's personal appearance, address and general deportment count for a great deal, but in engineering the quality above all is the product of training and ability to put plans into material. Of course, if the engineer has men under him, he has to know how to handle them, but about all they require is just treatment and a knowledge on his part of what he is doing. An admirable feature is that the profession strikes such an even balance between theory and practice and gives such a scope for both inductive and deductive theory. An engineer works out his theory and translates it into material. If he does not get the results anticipated, it is up to him to discard his theory or find out what is the matter. He must keep the two together—that is to say, his theories must be practical or he is a failure in his profession. Unlike the lawyer who builds up a great deductive system of jurisprudence and frequently ends in making a travesty of justice, and unlike the theologian who also builds up a great system by deduction and arrives at a conclusion diametrically opposite to that of his brother theologian, the engineer never reaches such a *reductio ad absurdum*, for his theory is tested in practice at every step. He may make mistakes in details, but these soon show up and he need have no fear of his profession being torn asunder by the discovery that part of his understructure is false, for that understructure has already been tried and found true.

The engineer should have a good opinion of his profession. This is very easy, as it is rising in public estimation every year, and as its advantages far outweigh its disadvantages. Among the former might be mentioned its universality. Like art, its principles are independent of language, race, religion, locality and human laws. The principles which govern the boring of the Alps are the same which govern in the Rockies under similar conditions. A bridge over the Zambesi follows the same rules as one over the Niagara and may easily

be designed by the same man. But a lawyer cannot go from even one province to another without having to study a new set of statutes. Not only are the principles universal as in medicine but, unlike medicine, the language is also universal; that is to say, the plans and drawings of our bridges and tunnels, etc., can be understood by any engineer be he Hungarian, French or of any nationality. In some large drawing offices in America there are many foreigners, some of whom speak very little English, but they are adept at design and draw good pay. This gives the engineer a wide field and limits him to no special country, climate or condition of men and things.

But an engineer has to take the consequences for his mistakes. If a lawyer looses a case through some oversight or poor work he has little trouble in making his client believe his case was rather weak, if indeed, his client ever questions the lawyer about his conduct of it. And if a doctor loses a case through imperfect diagnosis or wrong treatment it is very easy to leave the relatives under the impression that it was the inevitable. But not so the engineer. If his design is at fault and a train crashes through a weak bridge, the engineer has to take the consequences. He may not be hanged for murder, but he will lose his position and his reputation. It is not often that these accidents are traced to the engineer because his designs have been all tested step by step. He is well aware of the consequences of a mistake, and there can be no shuffling on his part. If President McKinley's death had been caused or even hastened by the explosion of a badly designed piece of apparatus in his sick room, instead of by giving him solid food too soon, the engineer or designer would not have gotten off with honor.

Deception has no place in engineering. Mother Nature will bring it to the surface sooner or later.

The profession, like trade and finance, is very materialistic. Every proposition has to answer the question, "Will it pay?" While nearly every one of them adds to the wealth resources, pleasure and other uses of mankind, still it is nearly always a materialistic advantage. Furthermore, the engineer deals entirely with materialistic force and matter, rarely with life, mind and spirit. To compensate for this, his recreation would follow other lines such as art, literature and sociology.

Another disadvantage is that it is apt to make one careless of the courtesies and amenities of life. However, this is very secondary compared with the first. A more serious one is that it is very difficult to get an independent position, or in other words, to have one's own business. There are a few consulting engineers, but most of them had to make their reputations as subordinates of big companies. An engineer is apt to devote all his time to technics and neglect the financial and executive side. This is the case in nearly every engineering office, the men are good engineers but they have not enough business to manage their own prospects to the best advantage. The result is they are simply tools of men who know less than they do but are good at business and draw bigger salaries. It would pay a young engineer in the long run to spend a vacation in a hustling real estate office, or at least selling engineering supplies. At any rate, he should seek a position where he will get business ideas and practise rubbing shoulders with his equals, rather than with his superiors, for then he will naturally fall into a secondary place and that should be avoided. A certain amount of office routine is necessary, but he should try to get a position where he will have field work along with it. This is a comparatively easy thing in civil, mining and hydraulic engineering, but very different in mechanical and electrical, and perhaps metallurgical and chemical.

All things considered, engineering is a fine profession and one which is rising in public estimation year by year because it delivers the goods. It has pierced the Alps and tracked the Andes; it has driven turbine boats at 40 miles per hour, steel railroad trams at 80, electric trams at 130 to 132. It has transmitted intelligence under the ocean and through the air, it has driven ships above the water, on the water and under the water; it has mapped the earth's surface, sounded the ocean's depths and has measured the winds in order to navigate three or more miles above the surface of the earth. It has gathered minerals from refractory rocks and transmitted water from mountains to desert and city. It has converted the refuse of great cities into valuable fuel and with it has raised the standard of health. It has built skyscrapers and cathedrals, raised hills and formed rivers. It has transmitted power more than two hundred miles over a small wire and may yet do it without the use of wire. Indeed, it would be hazardous to set any reasonable limit to the things the profession of engineering will accomplish.

AIR BRAKE TESTS ON THE PENNSYLVANIA RAILROAD.

IMPORTANT improvements in the braking of heavy passenger cars were described in a paper read before the American Society of Mechanical Engineers in New York, on February 10, by Mr. S. W. Dudley, of Pittsburg. These tests were conducted jointly by the Pennsylvania Railroad and the Westinghouse Air Brake Company. The results are considered the most important recent contribution to the subject of air brakes.

A train of 12 steel cars at 60 miles per hour stores up 224,000,000 foot-pounds of energy. This is sufficient to raise the entire train 120 feet. With prevailing brake equipment such a train would be stopped by an emergency application in a distance of 1,600 to 2,200 feet, according to the truck rigging and brake shoe design. These tests showed that this distance has actually been reduced to 1,000 ft., or to within the length of the train. This was the result of improvements in the truck brake design involving the clasp brake, having two shoes per wheel, and the location of the brake shoes with reference to the horizontal centre line of the wheels, in addition to improved methods of applying the air brakes quickly and simultaneously and at a high pressure. This concerns safety.

These tests emphasized, as has never been done before, the possibilities of improvement in efficiency and economy in regular service operation by proper attention to design and installation in order to permit the realization of the flexibility of improved air brake apparatus. These improvements centre in the electric control of the brakes, giving quick, simultaneous and responsive action. The electric control has opened the way for maximum effect in practice of improvements in practically all the factors involved in air brake apparatus, all of which were covered in the development represented by these tests. The tests constituted a progressive development of brake rigging and brake shoes in connection with the scientific study of the air brake as a whole.

Trains of 15 years ago were stopped in about half the distances prevailing in the practice of to-day. Increased size and weight of equipment brought an entirely new brake problem, which these tests have solved.

CONTRACTION AND EXPANSION OF CONCRETE ROADS—II.

ONE of the very important reports submitted at the National Conference on Concrete Road Building, Chicago, in February last was that of the committee on the contraction and expansion of concrete roads. The committee consisted of Messrs. R. J. Wig, N. H. Tunnicliff and W. A. McIntyre. *The Canadian Engineer* for March 19th, 1914, published the first portion of an abstract of the report. This portion dealt with the effects of changes in temperature and moisture content of the concrete, the effect of variation in the condition and character of the sub-base and the effect of traffic. The following sections, bearing upon the application of present knowledge to the prevention of cracks in concrete roads concludes our summary of the committee's report.

Cracks.—The committee expressed its belief that it is possible to prevent all cracking of concrete in roads, with a proper understanding of the physical phenomena affecting the expansion and contraction of concrete in roadways and a proper application of engineering principles.

Longitudinal cracks usually do not occur until seasonal changes. Transverse cracks may occur at any time, but the majority should occur during the first dry season.

Transverse cracks are probably due to a favorable combination of moisture content in the concrete and atmospheric temperature conditions, together with a restraint induced by the condition of the subgrade. They may, however, be caused by an unstable foundation.

Longitudinal cracks are probably in the majority of cases caused by an unstable condition of the sub-base, although they may be caused by a favorable combination of moisture content in the concrete and atmospheric temperature conditions, together with a restraint induced by the condition of the subgrade. The latter is particularly effective if the sub-base is crowned.

Diagonal cracks are probably most commonly caused by a combination of moisture content in the concrete and atmospheric temperature, together with a restraint induced by the condition of the sub-base. In rare cases they may be caused by the above combination and longitudinal restraint along one side when abutting a rough structure.

Effect of Quality on Cracking.—The best mixture is the one which is the most dense and which will reduce to a minimum the absorption of moisture, but it should also have a strength of at least 1,500 lb. per sq. in. at the end of 28 days. It should be mixed in such a way as to give a product of uniform quality. It should be placed in such a manner as to give a uniform quality of concrete in place and to prevent loss of water.

The sub-base should in all cases be thoroughly wet so as to prevent absorption of moisture from the concrete and thus cause a rapid drying out of the concrete.

The concrete should be cured in such a way that it will retain its own moisture and receive sufficient additional moisture until it is strong enough to resist the shrinkage stresses induced by drying out.

Relation of Slab Length to Cracking.—The maximum permissible length of slabs, of similar design, on a firm foundation, on a light or flat grade will vary with the climatic conditions. In localities where there is little rainfall, as in Arizona, or the San Joaquin Valley in California, the slab length probably should not exceed 25 ft. This length has been determined by an analysis of a report by A. B. Fletcher, State Highway Engineer, of California, on the cracking of a monolithic road, together with a knowledge of the results of measurements obtained by the Bureau of Standards.

In localities where the rainfall is intermittent and the ground water rises in cool seasons and lowers in warm seasons, similar to conditions which obtain east of the Mississippi River, the slab may vary in length from 30 ft. to a continuous slab. While the 30-ft. slab may be regarded as a minimum length, from economical considerations, the results of experiments indicate that cracks are quite likely to occur under certain conditions even in this length.

The data available would indicate that the length of the slab for the same sub-soil conditions does not affect longitudinal cracking. It is, however, interesting to note that in a report by A. N. Johnson, State Highway Engineer of Illinois, is to be found a statement that in roads constructed by him in 1912 with a total length of 2.3 miles he finds 9.1 slabs per mile, cracked longitudinally, transverse joints being spaced from 50 to 100 ft. apart, on roads 16 to 18 ft. in width. A report of F. F. Rogers, State Highway Commissioner of Michigan, on the Wayne County Roads, shows that on roads constructed in 1912 with a total of 9.6 miles, 9.5 slabs per mile, cracked longitudinally, transverse joints being spaced 25 ft. apart on roads 15 and 16 ft. in width.

The length of slab should vary with the quality of the concrete. In a short time a denser concrete will absorb less moisture and consequently will have less tendency to move; it will also have greater strength to resist stresses induced by restraint of the sub-base. A dense concrete is particularly of value where subjected to intermittent wetting and drying. In a dry climate where plenty of water is not available for curing the slab length should not exceed 20 ft.

The length of the slab should not be the same for all sub-soil conditions. If the sub-soil is of unstable material the length of the slab must be shorter than for a condition in which the sub-soil is stable.

If there is a distinct variation along the length of the road in the materials of which the sub-base is constructed a joint should be placed where the change takes place. This is necessary because of the change in the frictional restraint offered by different materials and also because of the difference in the porosity which changes the moisture conditions.

The length of the slab should vary with the condition of the sub-grade. If the sub-grade could be made very smooth so that a more or less uniform frictional resistance would be obtained throughout the length of the slab, it would perhaps be the most desirable condition, but as this is not obtainable it is believed that a more or less uniformly rough sub-grade is preferable to a so-called "smooth" sub-grade. This is explained by the fact that the rough sub-grade will make each small section in the slab care for its proportionate share of the stress induced by frictional restraint, while if the sub-grade is so-called "smooth" there will be rough places in it at intervals which will place upon certain sections undue stresses, which therefore will be more liable to cause cracks. If there is any decided change along the length of the road in the condition of smoothness of the sub-grade a joint should be placed at the point where this change occurs.

If the sub-grade is so-called "smooth" on a steep grade, the permissible length of slab would not be as long as a light grade, there being a tendency to slide down hill and thus add additional stress to that imposed by moisture and temperate change.

If the grade is steep the slab should be shorter in length than that used on a flat grade. A joint should be placed at all decided changes in grade.

It would appear that the slabs could be made longer if constructed during the fall or winter, in localities where not subjected to freezing, than if constructed in either the spring or summer, although there is not sufficient data available to determine whether this would permit of an appreciable change in length. Conditions indicate that concrete laid in the fall is probably not subjected to stress as much during the first few months, since the tendency to increase in length due to moisture is counteracted by the tendency to decrease in length due to temperature.

The experimental results indicate that there was greater movement of the concrete covered with a bituminous carpet than with concrete uncovered. This is indicated in Curves shown in Fig. 1 of covered and uncovered slabs. If, upon further investigation, this condition is found to hold true the slab length would probably have to be varied. The reason for the greater movement noted is probably to be explained by the fact that a dark surface absorbs more sun heat and the bituminous coating holds for a longer period any moisture which gets beneath it.

The length of the slab may be made greater for a greater thickness of slab. The increased friction caused by increased weight is proportionately less than the increased ability of the concrete to resist stress. Sufficient data are not available to give a relative figure.

It is not believed that traffic need be considered in determining the length of the slab.

There would tend to be a greater movement in a wide or elastic joint than in a narrow or unelastic one and since cracking occurs during contraction there would be less movement with a tight joint; a tight joint therefore would permit of a longer slab. It is not known, however, that this factor is sufficiently appreciable to be considered in determining the length of the slab.

Relation of Cross-Section of Slab to Cracking.—A concrete road laid on a crowned sub-base would be the most liable to crack longitudinally and on a dished sub-base the least liable to crack. The resistance offered to contraction of a slab with a crowned sub-base is greater than that offered by either a dished or flat sub-base, because the concrete must move against the effect of gravity. With the dished sub-base the concrete contracts with the effect of gravity and therefore is stressed the least.

The cross-section having the greatest thickness at the centre with a dished sub-base would offer the greatest resistance to longitudinal cracking; the cross-section having the least thickness at the centre with a crowned sub-base would offer the least resistance to longitudinal cracking.

It is not believed that transverse cracks are in any way affected by the width of the slab. The data available to the committee would indicate that the width of the slab for the same sub-soil conditions does not affect transverse cracking.

The slab should have its greatest thickness at the centre no matter where the longitudinal drain is placed.

Over an unstable sub-soil the slab should be made of greater thickness throughout the width than over a stable sub-soil, with the greatest thickness at the centre.

It is not necessary to vary the design of the cross-section of a slab with the condition of the sub-grade.

The dished is the preferable design under all climatic conditions, especially in arid regions.

The dished sub-base is the preferable cross-section for all seasons and especially so if the concrete is laid during the dry season.

The wider the road the thicker should be the slab.

It is not necessary to vary the design of the cross-section with the length of the slab.

A concrete road which must withstand heavy and concentrated traffic must be made thicker than for light traffic.

Value of Reinforcement in Preventing Cracking.—Reinforcement will be of value: (1) When the foundations are uncertain; (2) in regions where there is little rainfall and long or wide slabs are desired; (3) in regions where there is sufficient water for curing; (4) when it is necessary to have a thin slab; (5) when a decided change in grade occurs; (6) when the movement of the concrete is restrained at street intersections or on curves, if joints cannot be placed properly; (7) when the width of the slab is greater than 25 ft.; (8) when it is necessary to crown the sub-grade and the slab can not be made thicker at the crown than at the sides.

Only fabricated steel should be used and that form which will give the greatest distribution.

The quantity of reinforcement can only be determined by an analysis of the conditions affecting each specific case.

If uncertain sub-soil conditions tend to cause a settlement on the sides of the road, which is the most common condition, the reinforcement should be near the top. If settlement is apt to occur within the centre of the slab the reinforcement should be placed near the bottom, and where the whole of the sub-base is uncertain the reinforcement should be placed near both top and bottom. Reinforcement to resist stresses due to temperature and moisture changes should be placed near the bottom of the slab. The stresses set up by a change in temperature are insignificant, except in arid regions, compared with those set up by moisture changes, and ordinarily reinforcement to provide for temperature stresses is unnecessary.

The slab length may be anywhere from 20 ft. to continuous, depending upon the many elements entering into the problem.

The widest pavement without cracks within our knowledge is 40 feet. It is probable wider pavement can be constructed.

It would appear that if properly designed a thinner slab may be used if reinforced. Definite information, however, is lacking to exactly determine this fact.

The conditions of construction affecting cracking apply to plain concrete slabs as well as to reinforced slabs.

Effect of Joints on Cracking.—The purpose of joints is to relieve the stress which might be induced by a volumetric change in the concrete caused by change in moisture content or temperature and to care for unstable foundation conditions. The committee has no evidence of the failure of slabs in concrete roads due to buckling, crushing or spalling and therefore consider the joint as primarily for the purpose of taking care of contraction.

If a concrete road is constructed without considering the affecting factors, with the idea that nature will provide cracks, it will crack, but before doing so it will cause a weakening of the concrete for some distance on each side, which may result in a partial disintegration of the road. This is evidenced by short forked cracks appearing running off from the main crack. The cracks thus formed will gradually lengthen with time and will not only be irregular in alignment but they will not be vertical.

The width of the joint controls the longitudinal movement of the slab. A greater width will allow of greater movement, consequently the slab will be more liable to crack upon contracting.

A joint should be constructed as a contraction joint with little or no room provided for expansion, as all stresses in the concrete caused by expansion are compressive and may be absorbed by the concrete; later, upon contraction there will be little movement and therefore only small tensile stresses will be induced and there will be less liability of cracking.

Experimental results show that only the movements occurring near the ends of the slab are usually transmitted to the joints.

There are no available data to show the difference in effect of diagonal and square joints on expansion and contraction. Any joint, however, should be perpendicular so as to give proper bearing between adjoining slabs when they expand.

It is necessary to provide a longitudinal joint between the pavement and an adjoining structure if the adjoining structure is rough and will cause longitudinal restraint or if the abutting structure will not offer sufficient resistance to prevent being pushed out of place.

Joints should be placed at street intersections and at sharp curves so as to allow of free movement, wherever the concrete is restrained.

Effect of Character and Condition of Sub-Base on Cracking.—A rough sub-grade is preferable since a very smooth sub-grade is impracticable to construct.

The sub-base should be very dense, but not entirely impervious. Where a rich mixture is used in the construction of a road it would tend to dry out unduly, causing excessive contraction. If a smooth subgrade could be provided so that the friction would be reduced to a minimum it might be desirable to have an impervious sub-base, but this condition is very difficult to obtain.

It is desirable to have the sub-base uniformly and thoroughly compacted so as to prevent uneven settlement.

The sub-base should be dished.

Conclusion.—The committee observed that it had been fully established that the change in moisture content of the concrete was of much greater moment than the change in temperature under normal exposure; and that a proper combination of change in temperature, change in moisture content and friction have made possible the construction of long slabs which have remained free from cracks; while under an unfavorable combination of these factors, which is to be found in certain localities, long slabs have invariably cracked.

With a proper understanding of the physical phenomena, which are recommended for investigation, and with a proper application of engineering principles by competent highway engineers, it is believed by the committee that all expansion and contraction of concrete in roads can be so controlled as to permanently avoid cracking.

FORMS FOR CONCRETE WORK

WE do not often hear of failures occurring in reinforced concrete buildings after their completion, but generally during their erection, and although all failures cannot be attributed to defective forms, yet the forms are to blame in a sufficient number of cases as to render the forms for concrete work an important element in securing efficiency in construction, and not merely in the utilitarian aspect. Although it is not the general practice for engineers to design their forms, that being generally left to the contractor, Mr. Allan Graham, in a paper which he read on March 12th before the Concrete Institute, expressed his belief that an engineer, for his own protection, should at least set out some typical portion of the forms for the contractor's guidance, thus doing all he can to circumvent failure in this direction at any rate. Of course, good forms alone will not ensure safety, and vigilance should likewise be used in detecting bad work, bad design, and bad material. For, as Lieut.-Colonel Winn has pithily put it, "a fool with a shovel may absolutely defeat the most elaborate calculation involving the calculus."

Formwork is a term embracing all kinds of moulds or centering set up to give shape to the concrete or similar plastic material. It is so employed in America. There is a consensus of opinion in favor of the definition "formwork" as an inclusive term, owing to the real meaning of the term "centering" having a more limited application than usually attributed to it. As the word "form" is the same, and has the same meaning in French, German, Italian and Spanish, the author believes it will be agreed we are on safe ground if we accept it for our purpose. The term has great merit, being superior to such terms as falsework or shuttering.

The contention that the engineer should prepare the design of formwork has much to recommend it. An engineer will generally have no hesitation in setting out the design of centering for a bridge or other equally important work, but for some reason or other the design of ordinary formwork which plays such an important part in the cost of reinforced concrete is never considered. There is no doubt that a thorough understanding of the principles underlying the everyday practice of concrete form design is one worthy of the best engineering talent. With this understood, the problem can be analyzed, the requirements realized, and the design decided upon that will be the most economical and efficient, giving due consideration to the salvage of materials.

It is not merely that a design is required for a specific case which will safely support a certain volume of concrete, it is rather the problem of designing a set of forms which can be erected, taken down, and many times re-used during the progress of work. The factors involved are many, such as the type of centering, the kind of timber, how much to centre at one time, and what clamps, bolts, nails, wire or strap steel should be used. These things properly considered will repay the trouble taken and result in better and more economical work.

Various authorities place the cost of formwork at anything from 20 per cent. to 60 per cent. of the total cost. The possibility of reducing this hindrance to the more general use of concrete ought to be sufficient inducement for us to give the matter close consideration. American constructional firms have struck out in many directions to reduce this cost to a minimum, and to this end the forms in most instances are designed in the

drawing office, and this, it is reported, at a cost of 2 per cent. and a saving of 10 per cent.

In his paper Mr. Graham then dealt with the kinds of timber that are used for formwork, the desirability of giving a camber to the bottom of beam boxes, the desirability of carefully checking the measurements, to see that the concrete members are actually carried out as designed, the necessity of having joints close to prevent the mixture escaping, the remedying of cracks, the removal of forms, clamps and nails to hold the forms together, the repair and re-use of formwork, the number of sets required in order to get on fast enough with the work of building, the importance of carefully clearing forms of all sawdust, dirt and chips before filling with concrete, the wetting of timber to prevent sticking, the use of sheet metal, the time for striking forms and methods of determining the strength.

ELECTRIC RAILWAYS IN GREAT BRITAIN

In a report of the railway department of the Board of Trade it is shown that since 1878 the mileage of the tramways in Great Britain has increased from 269 miles to 2,662 miles, while the capital expenditures have grown from $20,447,721 to $385,688,425.

The number of passengers carried in 1878 was 146,000,000 and for the year ended June 30, 1913, 3,220,000,000 or about 71 times the entire population. Net receipts of the tramways in 1878 were $1,122,490, and in 1913, $27,158,268. Of the mileage 1,818 miles are operated by municipalities. Of the total mileage 2,637 are operated by electricity.

Of the 286 tramway enterprises 171 are municipal and 115 are owned by private parties. Included are 13 miles of trackless trolley, which as yet show a deficit in operation. The net receipts of the municipal tramways for the year were $19,905,445 and of this $6,314,840 were applied to reduction of tramway debts, $2,646,163 to reduction in tax rates and $3,629,200 were carried to surplus. In four municipal tramway enterprises cost of operation exceeded gross receipts and in 25 municipal enterprises it was necessary to raise additional revenue from taxes to meet some part of the charges for the year. The total amount thus raised was $315,840 in 1913, as compared with $301,960 in the preceding year, which seems to indicate that the deficits are growing.

The average receipts per passenger in 1913 was 2.13 cents, as compared with 2.158c. in 1912, 2.46c. in 1898, and 3.68c. in 1878. As practically all English tramways use a zone system of fares it is difficult to give a comparison between the rate of fare in English cities with those in this country, where generally a single fare is charged for a ride of any length.

FOURTH AMERICAN ROAD CONGRESS.

Mr. J. E. Pennybacker, secretary of the American Road Congress has announced that the Fourth American Road Congress will be held in Atlanta, Ga., during the week of November 9th, 1914.

At a meeting held in London, England, on March 12, the reconstruction of the Newfoundland Oil Fields Company, Limited, was approved. The proposal is for a new syndicate with Sir Henry Blake as president, and with a capital of $24,000.

MAXIMUM FLOOD DISCHARGES.*

It is sometimes important to obtain the maximum discharge or maximum gauge height which a given stream is liable to have. This has assumed increased importance lately because of the disastrous floods of the past year. Even in parts of the country where very serious floods have not yet occurred people have begun to realize that they may have such a visitation. Some rivers, like the Mississippi, because of their extreme importance, have been the object of special study, and there is much information on hand concerning them; but for many streams the engineer is at a loss how to estimate for the highest future flood. The common method is to take the greatest gauge height on record and assume that there are to be none higher in the future, a method which leads to bad results unless the records include an extraordinary flood, which they may not do, even if they extend over a considerable period. It is also dangerous if the unusual flood occurred some time since and conditions in the valley have changed in such a way as to cause higher water for the same discharge per second.

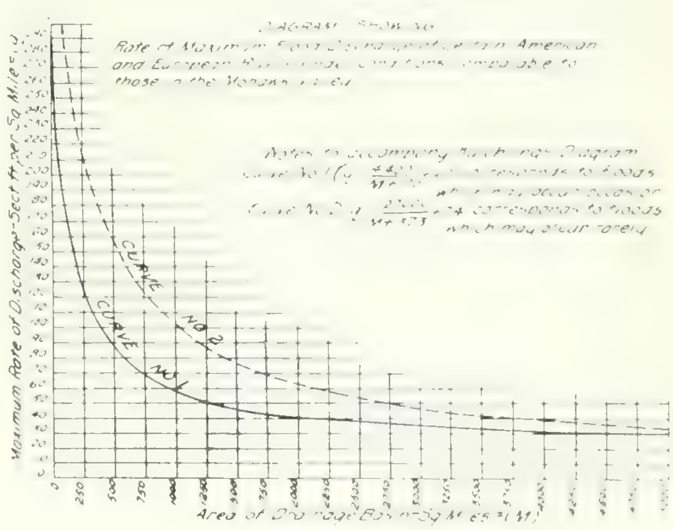

Fig. 1.

Another method of getting the maximum discharge is to look in encyclopedias, hand-books, text-books, etc., for information, and one is there met with all kinds of methods for getting the discharge. Some books will give the discharge in cubic feet per second per square mile for various kinds of country, from flat to very mountainous; some of them give the discharge as a function of the area, followed by a note saying that this formula applies to Northern India or Southern Italy, or some other place which the engineer is not interested in; and some books give the run-off from various classes of soil in terms of the rainfall. Then the engineer is as much at sea as ever, because the study of the rainfall is a complete problem in itself, and the flood may come from melting ice and snow or an ice gorge. The different results from the encyclopedia method do not seem to agree and the general result is more uncertainty.

Two studies on this subject have been made in recent years which seem to possess unusual merit. In connection with his report on the New York State Canal Survey, Mr. Emil Kuichling, M. Am. Soc. C.E., made an excellent study of flood flow on American and European streams. He obtained two equations which, with their

* From "Professional Memoirs" of the Engineer School, Washington Barracks, D.C., Vol. VI., No. 26.

corresponding curves, are shown on Fig. 1. It will be observed that the maximum rate of discharge is given per square mile in terms of the area of the basin in square miles, and small areas have a much larger unit flow. Curve No. 1 corresponds to floods which may occur occasionally, while curve No. 2 corresponds to floods which may occur rarely. The discharges indicated by curve No. 2 are larger than given by some authorities and much larger than are provided for in many places in this country. The reason of the latter is sometimes because people have not had that rare flood which may reach them any day, and against which many of them refuse to prepare until it has already occurred. The history of so many flood protection works is the story of a series of works with increased protection, the increased protection being added each time that a flood occurs larger than was expected. During the large flood which occurred in March, 1913, in the upper Scioto and Olentangy rivers, the discharge in each of these rivers at Columbus, Ohio, was, roughly, half way between the values given by the two curves. The Olentangy flows into the Scioto at Columbus. The discharge for the combined rivers is above the higher curve, or 90 second-feet per square mile with an area of 1,570 square miles, while Mr. Kuichling's curve No. 2 gives about 75 cubic second-feet for this area. (See report to City of Columbus on Flood Protection, by Alvord and Burdick, Hydraulic and Sanitary Engineers.) This would indicate that curve No. 2 is conservative. The flood at Columbus, while unprecedented for the Scioto River, would have been exceeded had the rainfall during March been moved only a short distance south or had there been snow on the ground. As it actually occurred, the belt of heaviest rainfall, instead of covering the Scioto Valley, covered only its upper portion, part of the belt extending across the watershed into the St. Lawrence basin.

Another excellent study which has been made recently was presented by Mr. Weston E. Fuller, M. Am. Soc. C.E., before the American Society of Civil Engineers and published in their Proceedings for May, 1913. Mr. Fuller's is a long and excellent article, and he presents a large number of tables with data from nearly all parts of the country, which are of great value in looking up the discharges that may occur in any particular section. Mr. Fuller does not compare floods by getting the maximum discharge, but compares the average flow for the day of maximum discharge, a method which has also been used by the United States Geological Survey. This average flow is obtained by dividing the total discharge in twenty-four hours by the number of seconds in a day. It will here be called the twenty-four hour flow, in counter-distinction to the momentary flow. Mr. Fuller compares the maximum twenty-four hour flow with maximum momentary flows, and also with what may be called average yearly flood flows.

Let Q (ave.) = average yearly flood flow obtained by getting the highest twenty-four hour flow for each year for a number of consecutive years and taking the mean expressed in second-feet.

Q = greatest twenty-four hour flow during a period of T years in second-feet.

Q (max.) = maximum momentary flow in second-feet.

T = the number of years in the period considered.

A = catchment area of the river in square miles.

For obtaining the relation between the flood to be expected in a series of years and the average yearly flood, he deduces the equation $Q = Q\ (\text{ave.})\ (1 + 0.8 \log. T)$, from which he computes the following table:—

Table I.

Time in years.	Ratio of largest flood to average yearly flood.
1	1.00
5	1.56
10	1.80
25	2.12
50	2.36
100	2.60
500	3.16
1000	3.40

Mr. Fuller further, for getting the relation between the maximum momentary flow and the maximum twenty-four hour flow in the same flood, deduces the equation $Q\ (\text{max.}) = Q\ (1 + 2A^{-0.3})$, from which he computes the following table:—

Table II.

Catchment area in square miles.	Ratio of maximum flood to average 24-hour flood.
0.1	5.0
1.0	3.0
5.0	2.23
10.0	2.0
50.0	1.62
100.0	1.5
500.0	1.31
1000.0	1.25
5000.0	1.15
10000.0	1.12
50000.0	1.08
100000.0	1.06

Frequently, gauge readings are available for a number of years, and if discharge observations are available a rating curve may be made, giving the relation between the discharge and the gauge height. Rating curves for many points have been made by the Geological Survey. With the gauge heights and the rating curve the value of Q (ave.) or the average yearly flood-flow may be determined, and by use of Table I. the largest flood against which it is desired to protect can be determined. The flood which occurs once in a thousand years will frequently be the proper one to protect against, as the thousand-year flood may be near at hand. With the greatest twenty-four hour flood so obtained you may proceed to Table II. and get the maximum momentary discharge, and by going to the rating curve translate this back into gauge heights if such is desired. Of course, one of the troubles with this method of Mr. Fuller's is in finding the value of Q, the average yearly flood-flow, as it is liable to be out badly unless the records for a long period of years are at hand; but, in any event, it is believed to be an excellent method of checking up results obtained by some other method, say, by Mr. Kuichling's curves. It has the great advantage of including all the peculiarities of the catchment basin, including rainfall and melting snow and ice characteristics. It is also of value where there are no discharge observations or rating curve, but otherwise sufficient gauge records available. This is probably a very common case. The discharge for each gauge height may be computed by use of Kutter's formulæ for the velocity $V = C\sqrt{RS}$ combined with the area of the cross-section. The area of the cross-section, the hydraulic mean depth, R, and slope, S, can be measured without waiting for a flood and by assuming *n* the coefficient of roughness, the value of C may be obtained from Trautwine's handbook or elsewhere. The rating curve may then be constructed, which is liable to be much in error

due principally to the value of n assumed, and by using Mr. Fuller's methods this error tends to come out "in the wash" by the time the results are translated back into gauge heights. Frequently it is the gauge heights rather than the actual discharge observations that are desired.

In their report, referred to above, Messrs. Alvord and Burdick used gauge records for sixteen years to find Q (ave.), the average yearly flood-flow for the upper Scioto, the Olentangy and the lower Scioto. Comparing these with the two highest floods on record the following ratios of Q (ave.) to Q are obtained:—

Table III.

	1913 Flood.	1898 Flood.
Upper Scioto	3.52	2.23
Olentangy	3.52	2.20
Lower Scioto	3.52	2.22

The value 3.52 is slightly greater than the ratio, 3.40, Mr. Fuller gets in Table I. for 1,000 years. 2.20 is between his ratios for 25 and 50 years.

Mr. Kuichling's studies naturally fall down when applied to some stream like the St. Joseph emptying into the Maumee at Fort Wayne, Indiana. This stream has a porous soil, and its maximum flood is only a fraction of that of the St. Marys River, the other tributary of the Maumee at Fort Wayne, although the St. Joseph has one-half larger drainage area. In such a case the methods of Mr. Fuller would naturally apply. But if there is nothing unusual in the basin of the St. Marys it would be safe to say it might have Mr. Kuichling's curve 2 discharge some day. The Scioto River, near at hand with its flood discharge, would indicate this.

Mr. Fuller's and Mr. Kuichling's studies seem to lend themselves to rivers the size of many of our navigable ones as well as small streams. In some cases other formulas or methods involving time and money for investigation give more accurate results, but the methods here presented give prompt results and often very valuable assistance. These methods, however, do not provide any factor of safety, they only give the maximum load. The levee or the bridge must be built a certain number of feet above the crest of the flood to provide this. It is desired only to call attention here to the factor of safety; it is too complicated a problem to be discussed in a few lines. It may be the best business risk to provide only against the ordinary flood without any factor of safety added. The land power-houses at the Ohio River Locks are being built with the idea that occasional floods will drown out the machinery.

PRELIMINARY STATEMENT OF MINERAL PRODUCTION OF QUEBEC, 1913.

The value of the products of the mineral industry of the province of Quebec in 1913 totalled $12,918,109. These figures are compiled from returns received by the Quebec Mines Branch direct from the producers. Although they are liable to change slightly, owing to additional dilatory returns, they are sufficiently near to give an accurate idea of the condition of the mining industry of the province. Annual mineral production since 1904 is shown by the following table:—

Year.	Value.
1904	[illegible]
1905	[illegible]
1906	[illegible]
1907	[illegible]
1908	[illegible]
1909	[illegible]
1910	[illegible]
1911	[illegible]
1912	[illegible]
1913	[illegible]

COST OF LOCATION SURVEY FOR A SHORT RAILWAY LINE.

ENGINEERING AND CONTRACTING, of Chicago, recently published some cost data that will be found interesting and of value, compiled from accurate records made in relation to some location surveys run in 1912 for a railroad. The survey was for a branch 30.75 miles long, from an already established line to a manufacturing city; with a branch survey, to another city, 12 miles in length. Topographical considerations, aside from large bodies of water and high hills, were found to be of minor importance, the chief concern being so to approach the intersected streets that grade crossings might be cheeply avoided. Most of the distance was through a light growth of timber, requiring much chopping and trimming. No topography was taken, but all streets and water courses along the line were carefully surveyed and the boundaries of private lands were run out.

For three weeks the men were boarded in hotels in the two terminal cities; during nine weeks they were carried by team or railroad to the work from headquarters on the main line; and for twenty weeks and two days they lived in camp. From the camp, which occupied three different sites, about 26 miles of location were made, teams being kept with the camp for transportation.

Table I.—Distribution of Labor.

Description of work.	Cost.	Cost per mile.	Pct. of labor total.	Pct. of grand total.
Running the line finally adopted	$1,500	$35.10	39.7	20.8
Running lines afterwards abandoned	432	10.10	11.4	6.0
Surveys of intersected streets	666	15.60	17.6	9.3
Leveling on line finally adopted	156	3.65	4.1	2.2
Leveling on lines afterwards abandoned	65	1.52	1.7	0.9
Leveling on intersected streets	20	0.47	0.5	0.3
Meandering ponds and streams	57	1.33	1.5	0.8
Surveying private boundaries	382	8.95	10.0	5.3
Triangulation and traverse lines	146	3.42	3.9	2.0
Exploration	10	0.23	0.3	0.15
Check levels	10	0.23	0.3	0.15
Office work by field men..	61	1.43	1.6	0.8
Holidays, absences and rainy days	270	6.55	7.4	3.8
Totals	$3,784	$88.58	100.0	52.50

Table I. of labor distribution does not include any general officers' salaries nor that of the chief engineer. The map drawing was done in the general office and does not figure in these tabulations.

Surveying instruments were supplied from those previously in use by the company, and interest on their cost is charged under "Field and Office Equipment." The camp equipment, consisting of seven tents, complete mess outfit, cot beds, blankets and quilts, was purchased second-hand at a discount of 50 per cent.

During the nine weeks above mentioned many days were lost on account of rain for which the men, being at home, were not paid. The pay of the party was as follows:-

Position—	Pay per day.
Assistant engineer in charge	$ 4.50
Transitman	3.33
Leveler	2.50
Axman and teamster, 7 days per week	2.25
Chainmen	2.00
Rodman	1.75
Axemen	1.50
Cook, per week	15.00

The total cost per mile given, $168.08 (Table II.) is the cost per mile of final location, and will be seen to include the cost of preliminary lines, and all the detail surveying necessary for complete land plans.

Table II.—Distribution of Expenses.

	Cost.	Cost per mile.	Pct. of exp. total.	Pct. of grand total.
Field and office equipment	$ 160.49	$ 3.75	4.7	2.2
Railroad and street car fares and expenses	453.73	10.60	13.3	6.4
Board and lodging	167.00	3.90	4.9	2.3
Team transportation	836.32	19.50	24.6	11.6
Camp equipment	209.16	4.90	6.2	2.9
Camp maintenance	1,488.92	34.82	43.9	20.7
Purchased information	81.38	1.90	2.4	1.4
Mail, telegraph and telephone	5.56	0.13	...	...
Totals	$3,402.56	$79.50	100.0	47.50
Grand totals	$7,186.56	$168.08	.....	100.00

Table III.—Analysis of Camp Maintenance.

Commodity.	Cost.	Cost per meal—4,047 meals.	Cost per man per day.	Pct. of total cost.
Meat, fresh and canned	$ 373.72	$0.092	$0.239	25.1
Fish, fresh and canned	51.93	0.013	0.033	3.5
Potatoes	29.84	0.007	0.019	2.0
Other vegetables	53.93	0.013	0.034	3.6
Fruit, fresh and canned	120.58	0.030	0.077	8.1
Groceries	108.56	0.027	0.069	7.3
Flour	31.92	0.008	0.020	2.1
Eggs	59.39	0.015	0.038	4.0
Sugar	27.49	0.007	0.018	1.9
Coffee	26.50	0.006	0.017	1.8
Tea	9.06	0.002	0.006	0.6
Butter	37.27	0.009	0.024	2.5
Milk	73.03	0.018	0.047	4.9
Ice	18.61	0.005	0.012	1.3
Fuel	36.23	0.009	0.023	2.4
Light	6.50	0.002	0.004	0.4
Water—6 weeks from city main	5.00	0.001	0.003	0.3
Land rentals	10.00	0.002	0.006	0.7
Cook's wages	305.34	0.076	0.196	20.5
Labor moving camp	104.02	0.026	0.067	7.0
Totals	$1,488.92	$0.368	$0.952	100.0

A study of the tables does not suggest much resemblance to similar ones previously published, the most marked difference appearing in the matter of camp maintenance, Table II. Much of the higher cost shown here is doubtless due to the high cost of living now prevailing. Also much may be due to the fact that all the men were accustomed to a pretty good table and an effort was made to provide them with home comforts.

SOME POINTS IN LAND SURVEY WORK.

By J. A. Macdonald, Ottawa, Ont.

IN surveying a field for the purpose of finding its area, the instruments and methods will be determined largely by the degree of accuracy required. If it is permissible to have an error of 0.5% the compass and chain are most conveniently used. If greater accuracy than this is required it will be necessary to use the transit and the steel tape. At the present time, however, in nearly all work except surveys of farms and woodlands, the transit is used even under conditions where the compass would give sufficient accuracy. In surveying a field, for example, all the angles and lengths of the sides are determined consecutively, the survey ending at the point from which it was started. By trigonometry the position of the final point, as of any other point with relation to the starting point, can be readily calculated. If the survey were absolutely correct the last point as calculated would coincide with the first, but this condition is never attained in practice. The calculated distance between the two, divided by the perimeter of the field is called the "error of closure." The term more properly applies to the actual distance by which the survey fails to close, and even when it actually closes in the field, it will not close in the plot. In surveying with a compass and chain the error of closure expected is about 1 part in 500.

In his own experience in land surveying, with both a transit and compass available, the writer has found little use for the transit in what is known as "custom work." Even when using the transit the magnetic needle on the transit must determine the meridian, and as all the surveying that had been done in Canada and elsewhere up to a few years ago was done by magnetic bearings, all work on old lines, such as retracing, re-surveys, subdivisions, etc., must necessarily be referred to the magnetic meridian; hence the absolute need of the compass.

If the transit is used in re-survey work in our old and settled provinces, it is of the greatest importance that the magnetic needle is of good length, and in good working condition, because one must ascertain his bearings by the needle. Even if he took the trouble to take an astronomical observation for azimuth the result would be of practically no value to the surveyor on such old work as retracements, re-surveys, etc. It is the writer's opinion that on the whole, for the surveyor who is doing "old work," a good compass will be found of more advantage than a transit. But if a transit can be obtained containing a reliable compass, with needle not less than 4½ inches long, there are added advantages in having a transit, though it is so much more cumbersome to carry about. As already stated, it all depends upon the nature of the work, but if errors are permissible of, say, 0.5%, or if much old work is to be done in the rural districts, then the compass is to be preferred. If the opposite condition prevails, and if much of the work is to be done in

towns and cities, then the transit must in all cases be used. The land surveyor should, however, possess both the compass and transit if the nature of his work varies.

Surveying for Area.—In making a survey it is customary to begin at some convenient corner and to take the bearings and the distances in order around the field. As the measurements are made they are recorded in a field book. It is not always necessary to take the sides in order, but since they must be arranged in order for the purpose of computing the area it will be convenient to have them so arranged in the original notes. It is of the utmost importance in every survey that check measurements be taken. Even a few rough checks taken in the field, which will require only a little extra time, often prove to be of great value in detecting mistakes. Both a forward and a back, reversed, bearing should be taken at each corner. From them the angles at a corner can be obtained free from error due to any local attraction of the needle. With the compass it is often impossible to set the instrument up at the corners of the property, and in such cases assumed lines running parallel, or approximately so, to the property lines can be surveyed and the area determined. In some cases the instrument can be set on the property line at an intermediate point and the bearing obtained; but the surveyor must be sure that there is no local attraction of the needle at this point. All points where a compass-instrument is set should be marked and described so that they can be found again. If any instrument point is not otherwise defined it may be temporarily marked by a small stake and several reference measurements made from this stake to prominent objects nearby, so that the position can be determined if the stake is lost.

Division of a Property.—In order to divide a piece of land into two equal parts, the first thing the surveyor would do in most cases is to measure the width of the field on a course perpendicular to the sides. But in the case illustrated in Fig. 1 a river intervened, running in the direction of such a line and with its banks covered with a dense growth of alder and marsh, an almost impossible condition through which to cut a line. Another creek, with steep banks intervened further on, and the remainder of the area was covered with a dense growth of forest trees. By extending the outlines at (o) and (3) across the road and into the property to the east, a solution of the difficulty would seem apparent, but, to extend or prolong the line at (o) involved difficult cutting out of a line, while to the north of the river, and east of the road, was private property, most of which was under tillage, etc.

A simple method of overcoming these difficulties was devised by traversing the road from the post at (o) to the opposite side of the area at (3) and when completed calculating the latitudes. At Station (o) the instrument was set up and an angle or bearing of 18°00 (N.18°00'.E) turned, and the line measured to (1), 9.00 chains. At (1), the bearing was N.14°15'.W, and the line to (2), 3.10 chains. At (2), the angle was 35°00', (N., 35°00', W) to (3). These courses, with their latitudes and departures, dotted, are shown in Fig. 1.

One might be inclined to think that to divide a piece of land with parallel sides would be an extremely simple matter. Were the property abutting upon a straight road at right angles to the side lines no doubt the finding of the centre would only be a matter of measurement; but running in a semi-circular form, as the road does in Fig. 1, renders the problem somewhat difficult, since to go to the labor of opening a line through the wood, at right angles to the sides, could not be done without an instrument.

Table I.—Traverse.

Station.	Bearings.	Distance.	Latitude.	Departure.	Total latitude.
(o)	18°00	9.00	8.56	2.75	....
(1)	14°15'	3.10	3.00	.75	8.56
(2)	35°00'	3.20	2.62	1.83	11.56
(3)	....	...	...	...	14.18

The total width of the lot to be equally divided is therefore 14.18 chains, and the centre will be 7.09 chains from either side to make an equitable division. We now undertake to find the point 7.09 chains from Sta. 3. This will be a simple matter as we already know the distance from (3) to (2), and from (2) to (1) or 5.62 chains. The centre will then be 1.47 chains in latitude from Sta. (1) (7.09 — 562 = 1.47). Knowing the latitude and the angle from (1) to (o) (which is the same as the angle at

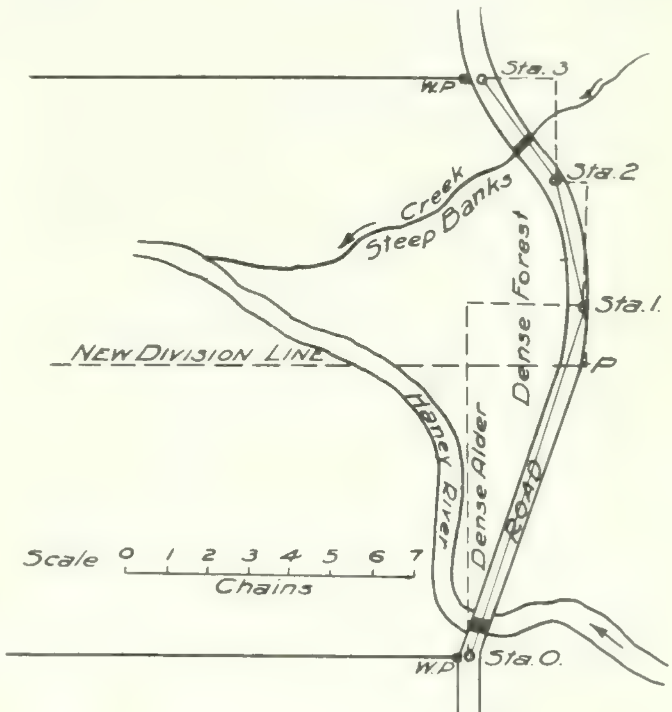

Fig. 1.

(o), viz., 18°00), divide the latitude, 1.47, by the natural cosine of 18°00' to obtain the distance to the point, P, the centre. This is found to be 1.54. By measuring back on the road line 1.54 chains, we are at the precise centre, 7.09 chains. At this point, P, we set up and run the division line east, parallel to the side lines, or outlines of the lot. Thus, by a little ingenuity and trigonometry the precise division of the contained area was obtained without having to cut out a line or trespass on the adjoining private property.

Note Keeping.—All measurements should be recorded in a special note book as soon as they are made and not left to be filled in from memory. The notes should be neat and clear, so that there will be no doubt as to their meaning. Great care should be taken so that they will not be susceptible to any interpretation except the right one. They are generally recorded in pencil, but they should always be regarded as permanent records and not as temporary memoranda. As other persons who are not familiar with the locality will probably use the notes and will depend entirely on what is recorded,

it is very important that the notes should contain all necessary data without any superfluous information. If the notekeeper will bear in mind constantly how the survey is to be calculated or plotted it will aid him greatly in judging what measurements should be taken and what are unnecessary. Clearness is of the utmost importance in note keeping, and to attain it the usual custom is not to attempt to sketch to scale. Yet, in surveys where considerable detail is desired, it is sometimes well to carry out the sketches in the note book approximately to scale. Care should be taken not to crowd the notes—paper is cheap—and an extra page of the note book devoted to a survey may save hours of time consumed in the office in trying to interpret a page of crowded data.

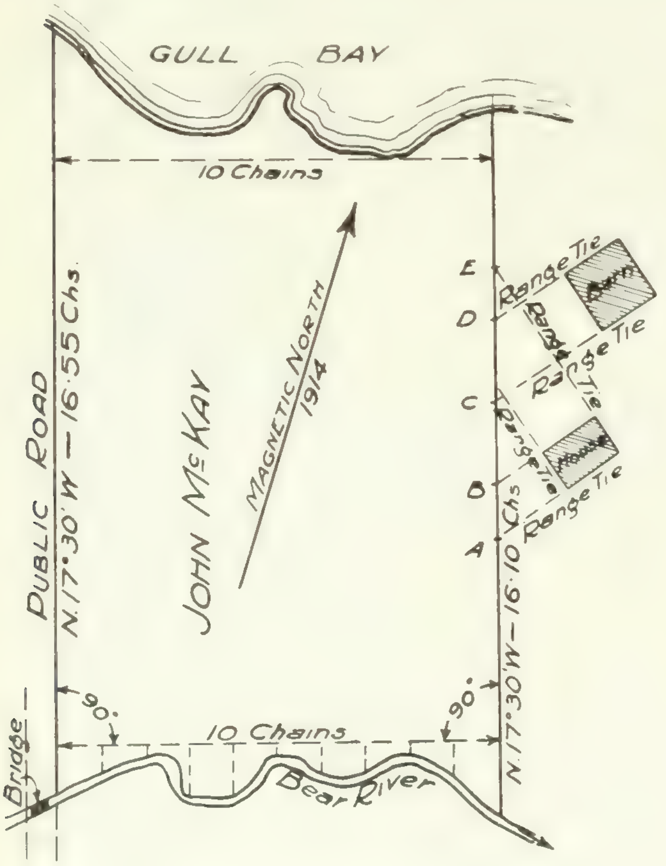

Fig. 2.

Where the work is of an intricate nature, the sketch should show roughly with pencil the various triangulations, etc., as in Fig. 1. This will greatly aid in the plotting.

Too much stress cannot be laid on the importance of being careful not to lose the note book, as not infrequently a note book contains data which thousands of dollars could not replace.

Although sufficient fullness to make the notes clear is desirable, it is customary to abbreviate the names of the features most commonly met with by the surveyor. To properly understand a set of notes one must be familiar with these abbreviations, as W.P., wooden post; I.P., iron post; I.P.M., iron post and mound; I.P.Pits, iron post and pits; Wit.I.P. or Wit.I.P.M., witness iron post—a monument placed some distance from the precise spot or true corner where a monument should be, but, owing to obstructions, cannot be made there; Temp. P., temporary post; etc. Distances should always be recorded in the note book in such a way as to indicate the precision with which they are taken. For example, if they were taken to 1/100 ft. and a measurement happened to be just 124 ft., it should be recorded 124.00. The two zeros are of as much consequence as any other two digits which might have come in their places. In addition to the measurements, every set of notes should contain the following information: Kind of work, locality, date, names of members of the field party, instruments used, etc. Where a survey is continued for several pages, the date may be placed at the top of every page, but the the other data need not be repeated.

Survey for a Deed.—In this case the lengths and bearings of all the boundaries are desired. The traverse lines should therefore follow the property lines, if possible. In case a true meridian is found by observation or by calculation, the bearings should be referred to this and marked "true bearings" by a note on the plan. This information should also be contained on the deed. More frequently, however, it is the magnetic bearing that is given. A plan which is to accompany a deed should show such features as watercourses, highways, buildings, and adjoining property lines, as well as stone mounds, stakes, fences, walls, or other artificial objects which mark the boundaries of the property. This plan should contain the following information:—

Lengths of all property lines together with their calculated bearings, or the angles at the corners; location and description of corner bounds; conventional sign or name on fences, walls, etc.; names of highways, streams or ponds, and of adjacent property owners; scale of drawing and direction of the meridian used. (It is better to refer all bearings to the true meridian when this is possible, and in such a case the direction of the magnetic needle should be shown in addition.)

The title should include a simple and complete statement giving the name of the owner, place, date and name of surveyor.

The written description of the property which is recorded in the deed should be given by bearings, or angles, and distances, stating in every case how the sides of the property are marked and whether bounded by a highway, stream or private property, giving the name of the present owner of the adjacent property.

It is customary with many surveyors to omit from the plan certain of the above enumerated data, so that while it may answer the purpose for which the survey was made, it does not contain all the data, and frequently not enough to enable another surveyor to relocate the property by means of it. This is done, of course, so that when the tract is to be re-surveyed, plotted, transferred or conveyed by deed to another party, it will be necessary to employ the same surveyor who has in his possession data for which the owner presumably has paid, and which the surveyor should have turned over to him on the completion of the survey. The plan and description of the survey should be so plain that any other surveyor could instantly interpret it, or that a lawyer could draw up the conveyance or transfer directly from the descriptive plot without confusion.

Judicial Functions of the Surveyor.—In running old and obliterated property lines, the surveyor is called upon to set aside temporarily his strict adherence to the mathematical side of surveying, and must endeavor to find, if possible, where the lines originally ran. He should, therefore, be familiar with the relative importance of evidence regarding the location of the property lines. It is his duty to find the position of the original boundaries of the property, and not attempt to correct the

original survey, even though he may be sure that an error exists in it. This is the concensus of opinion among surveyors, and also of the courts, and should never be lost sight of. Very often it is true that, owing to the cheapness of land, the original survey was roughly made, with little thought of the effect it would have when the land became valuable.

The surveyor, therefore, must first of all acquire all physical evidence of the location of the boundaries. Failing in this, he will use his best judgment on any and all other reliable evidence, such as occupancy or possession or the word of competent witnesses. It must not be assumed that boundaries are missing because they are not at once visible. Stone mounds are often buried two or three feet deep, while the top of a stake soon rots off; but evidences of the existence of the stake are often found many years after the top has disappeared. The supposed location should be carefully dug over to find traces of the old stake.

A dispute between adjoining owners over the location of a boundary line presents a question which must be settled by the courts unless the parties can come to an agreement. In such cases the surveyor has to act simply as an expert judge as to where the line originally ran, and he has no power to establish a new line. He can, however, be employed as an arbitrator to decide on the equitable line, but they are not necessarily obliged to accept his judgment. If they come to an agreement, however, between themselves in the presence and with the concurrence of the surveyor, regarding the location of the line, and occupy to that line, this agreement is binding, even though no court has intervened in the matter.

It is to be assumed that the deed has been drawn by the grantor with honest intent to convey the property to the grantee. It is intended, then, that it shall be interpreted, if possible, so as to make it effectual. The deed should also be construed in the light of what was known at the time when the title was transferred. In this interpretation it is assumed that it was intended to convey property, the boundaries of which will form a closed traverse. It is then within the jurisdiction of the surveyor to reject any evident mistake in the description when running out the property line. Where artificial features are mentioned as boundaries, these always take precedence over the recorded measurements or angles, but these marks must be mentioned in the deed in order to have the force or authority of monuments. When the area does not agree with the boundaries as described in the deed, the boundaries control. All distances, unless otherwise specified, are to be taken as straight lines, but distances given as so many chains or feet along a highway or street are supposed to follow these lines, even if they are not straight. When a deed refers to a plan the dimensions on this plan become a part of the description of the property. When property is bounded by a highway, the abutters usually own to the centre line, but where it is an accepted street each abutter yields his portion of the street for public use, but if it happens that the street is abandoned the land reverts to the original owners. If a street has been opened and used for a long period, bounded by fences or walls, and there has been no protest regarding them, these lines hold as legal boundaries. In the case of a line between private owners acquiescence in the location of the boundary will usually make it the legal line. But if there is a mistake in its location and the question of its position has not been raised, occupancy for many years does not make it a legal line, though the rule or "law" of "21 years peaceable possession" make a strong legal claim. Where property is bounded by a non-navigable stream, as south boundary of Fig. 2, it extends to the thread of the stream., i.e., the centre of the channel. If the property is described as running to the bank of a river it is interpreted to mean to low-water mark, unless otherwise specifically stated. Where the ownership originally ran to the shore line of a navigable river and the water has since receded, each owner is entitled to his proportional share of the channel of the river.

Irregularly Curved Boundaries.—When a tract of land is bounded by an irregular curved line, such as a brook, as in Fig. 2, it is customary to run the traverse line near it, and may be sometimes crossing it several times, and to take perpendicular offsets to the brook. (These offsets are shown in Fig. 2.) If it is a winding brook with no distinct turns in it, offsets at regular intervals are measured from the transit line, as in the portion of the south boundary, Fig. 2. Since they are usually short, the right-angled offset lines are frequently laid off by the eye, or simply paced.

PERSONALS.

S. P. BENNETT has been appointed Municipal Engineer of South Vancouver municipality.

JAMES WOODRUFF has been appointed Road Commissioner for the township of Niagara.

R. PIERCEY has been appointed chief assistant and C. K. SAUNDERS assistant to W. J. Johnson, Engineer of Saanich Municipality, British Columbia.

PHELPS JOHNSON, president of the St. Lawrence and Dominion Bridge Companies and past president of the Canadian Society of Civil Engineers, is on a trip through Western Canada.

S. B. WASS, assistant chief engineer, St. John Quebec Railway, is chief engineer of the Quebec Extension Railroad, a proposed line 174 miles in length in Quebec and the State of Maine.

C. A. P. TURNER, consulting and contracting engineer, Minneapolis, advises us of the removal of his office in that city from the Phenix Building to the new Walker-Burton Building.

F. A. GABY, chief engineer of the Hydro-Electric Power Commission of Ontario, addressed the members of the Canadian Institute on March 21st. Mr. Gaby's lecture was a general treatment of the development and use of hydro-electric power.

VINCENT SIMPSON, secretary-treasurer of Gerald Lomer, Limited, Montreal, is making an extended business trip through the West in the interests of the Phœnix Steel Pipe Works, of Dusseldorf, and Deutsche Maschinenfabrik, A.G., of Duisburg, Germany.

R. F. HAYWARD, general manager of the Western Canada Power Company, addressed a recent meeting of the Manufacturers' Association of British Columbia on the subject of power. He outlined the increasing advantages and the utilitarian value of electrical power in a wide range of industries.

Several years ago, a scheme was advocated to construct a bridge across the gorge at Niagara Falls, N.Y., below the falls and close to the foot of Niagara Street. This project is being revived

Coast to Coast

Edmonton, Alta.—The deficit of the Edmonton Street Railway department for 1913, which amounted to $190,000, has brought the actual deficit of that department, after six years' operation, to almost $400,000.

Toronto, Ont.—The Ontario Legislature has favored urging upon the Federal Government the importance of granting a measure that will stimulate anew the iron industry of Canada, the form of assistance to be left to the discretion of the Federal Ministers.

Montreal, Que.—Improvements effected by the new Montreal Harbor Commission during its first year of office in 1913, necessitating an expenditure of $3,787,430 on capital account, and $1,325,6[illegible] on revenue account against which there were total revenue receipts of $1,361,964, are shown in the annual report of the commission recently issued.

Ottawa, Ont.—The powerful ice-breaker, for which the Ottawa Government has recently awarded a contract to the Canadian Vickers Company, will be of 8,000 h.p. The plan is to put the ice-breaker at work at the Cap Rouge [illegible] bridge, prevent the accumulation of ice and afterwards to work between there and Montreal along with the Lady Gray and Montcalm. Not only will the opening of navigation be greatly advanced, but the spring floods along the St. Lawrence obviated.

Fredericton, N.B.—The C.P.R. has prepared plans for considerable work on the Atlantic Division for the present season; and while the work to be done will not be so extensive as during the past few years, it will be sufficient to maintain the efficiency of the line. Thirteen miles of new 85-pound rails will be laid on the main line between St. John and Megantic. On the main line, also, 40 wooden and dry stone culverts will be replaced by concrete, as well as a number of culverts on the branch lines. Twenty-five miles of ballasting will be done on the main line; while on the branch lines 61½ miles of light rails will be replaced by heavier rails, and 55 miles of ballasting will be done. A new loading siding will be built at St. Stephen; at Cardigan, at Burnside and Zealand on the Gibson branch loading sidings will be extended; and at Somerset Junction, in Maine, a new freight shed and two additional sidings will be built.

Vancouver, B.C.—The P.G.E. Railway Company has decided to proceed this year with the work on the establishment of docks and terminals at Squamish, and has estimated the expenditure for 1914 at $200,000. The company's plans for the year call for the reclamation of the tide flats of at least a mile in area, and also for dredging a considerable portion of the harbor. Also, it has been stated by Mr. J. W. Stewart, president of the company, that the company expects to award contracts by May 1st for the construction of the portion of the Peace River route; and it is expected to cover 100 miles of the new line this summer and to have grading on the entire section of 330 miles north-east from Fort George under way in the summer of 1915. The extension is to be finished and ready for operation right through to the Alberta boundary in 1916. Grading will be rushed on a section 150 miles from Fort George to connect with the portion now under construction north of Clinton, and on the other contracts to be let this season.

Victoria, B.C.—Dredging operations of the site of the new Marine and Fisheries depot have reached such a stage that the successful tenderers will be able to proceed with the construction of the Government wharf immediately the contract has been awarded. For the past three months the dipper dredge Mudlark has been confining its operations closely to the deepening of the channel in the immediate vicinity of the proposed wharves, until, at the present time there is a uniform depth of 18 feet at low water on the north side of the proposed wharf, while great progress has been made in digging out the hard-pan parallel with the channel. Already on the north side, running inshore to the Songhess Reserve, the Mudlark has taken out 52,000 cubic yards of material, and the dredge is now engaged in dredging out 35,000 cubic yards from the foreshore, running north and south. Upon the completion of this work during the next month, a total of 87,000 cubic yards will have been removed. When completed, the new Government wharf will be 450 feet in length, running north and south on the channel side, and will run inshore 210 feet, giving a depth of from 18 to 20 feet of water at low tide

Victoria, B.C.—The Provincial Legislature has considered recently the estimates for the fiscal year, 1914-15. The estimated expenditure has been placed at $13,742,009.60, and the estimated revenue at $10,048,915.15. Among the votes affecting engineering projects at Victoria and in the immediate vicinity, are: $340,000 for Soughees Indian Reserve improvements; $315,000 for the extension and completion of the provincial parliament buildings; and $245,000 for the completion of the provincial Normal School. The total estimated expenditure on public works throughout the Province is $5,316,575. Of this amount $2,319,500 will be spent on works and buildings; $2,861,000 on roads, streets, bridges and wharves; $96,075 on subsidies to steamboats, ferries and bridges; and a balance of $40,000 on general contingencies. Other votes of important engineering interest coming under appropriations for other departments of the government are $500,000 for work upon the new provincial university; $150,000 for government buildings at Prince Rupert; a revote of $50,000 for the completion of the courthouse at Vernon; a conditional revote of $400,000 for the bridge across Second Narrows, Burrard Inlet; and a vote of $100,000 for development work at Strathcona Park. The appropriation for the Forestry branch showed an increase of $78,000; the Lands branch, a decrease of $124,000; the Surveyor-General's department, a decrease of $165,000; but the Water Rights branch, an increase of $67,000.

St. John, N.B.—The report of Mr. Monsarrat, chief engineer of the Quebec bridge construction, upon the most suitable site for a bridge on the St. John Valley Railway over the River St. John, stated that borings at Dunham's Wharf, one and a half miles above the Mistake, the point previously most favored, disclosed a deposit of sand 50 to 60 feet deep overlaying clay which would furnish a satisfactory formation for supporting piles upon which to build concrete or masonry piers. Towards the east shore he had located the 500-foot span which would provide for no interruption to logging operations, and on the west side near the deeper channel, a 25-foot swing span. He believed this to be the best of three projected sites. He would not recommend any earth or rock filling. He was satisfied a bridge could be constructed across the river at this location which would cost approximately $2,063,756, subdivided as follows:—superstructure, $543,715; substructure, $1,283,877; rock fill, $47,000; track and telegraph, $1,550; engineering and contingencies, $187,614. However, the Foundation Company, Limited, of Montreal, had been asked to make an examination and to give an estimate on the work. That company concurred in the desirability of the site recommended, and reported that it could build the substructure for the sum of $1,135,000, and have it completed by December 1st, 1915; and also could so arrange the construction of the piers that the steel work could be erected by December 31st, 1915.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page [illegible] a directory of such societies and their chief officials.

D.L.S. EXAMINATIONS.

The result of the examinations held in February by the Dominion Land Surveyors' Association were announced last week. Examinations were held in the principal cities of the Dominion, and the number of candidates were 199. From the following results it will be noted that out of this number 15 candidates passed their final examinations, 37 passed the full preliminary and 3, the limited preliminary test. The list is as follows:—

Final.—F. Alport, Orillia; H. C. Bingham, Regina; L. E. S. Bolton, Listowel; R. F. Clarke, Kingston; H. J. Ewan, Yarmouth, N.S.; J. F. Fredrette, Ottawa; A. M. Grant, Ottawa; J. A. S. King, Ottawa; R. A. Logan, Middle Musquodoboit, N.S.; C. S. MacDonald, Ottawa; P. J. McGarry, Toronto; W. H. Norrish, Ottawa; B. C. Pierce, Kingston; G P. Sharpe, Salmon Arm, B.C.; R. L. Squire, Ottawa; F. H. Wrong, Sandwich, Ont.

Full Preliminary.—C. H. Biddell, Regina; J. C. Bonham, Kingston; C. A. Buck, Edmonton; F. R. Burfield, Calgary; L. C. Calder, Bergen, Alberta; J. Carroll, Toronto; C. W. Cohoon, Ottawa; W. S. Cole, Kingston; C. W. Crowell, Yarmouth, N.S.; E. M. DesBrisay, Montreal; G. H. Donaldson, Ottawa; W. L. Frame, Montreal; J. T. Fullerton, Montreal; C. E. Joslyn, Kingston; K. Keeping, Montreal; G. L. Kezar, Britannia Heights, Ont.; A. M. Knight, Edmonton; C. A. R. Lawrence, Toronto; C. C. Lindsay, Montreal; J. E. Lyon, Ottawa; F. J. Martin, Winnipeg; A. H. Meitz, Toronto; T. S. Mills, Prince Albert; W. S. McDonald, Edmonton; M. D. McFarlane, Montreal; H. R. Mackenzie, Regina; H. A. Parker, Blairton, Ont.; J. M. Paul, Calgary; G. B. Patterson, Kingston; H. B. Pelletier, Montreal; C. E. Richer, Ottawa; J. Robertson, Lachine Locks, Que.; D. N. Sharpe, Winnipeg; G. J. Smith, Kingston; C. H. Tory, Edmonton; A. G. Wilkins, Ottawa; H. C. Wright, Roblin, Ont.

Limited Preliminary.—L. C. Prittle, Carleton Place, Ont.; J. H. Ramsay, Ottawa; G. A. Wall, Calgary.

CAN. SOC. C.E.—VANCOUVER.

The Vancouver branch of the Canadian Society of Civil Engineers had a meeting on March 18th, which was addressed by Mr. J. W. B. Blackman upon the subject of town planning. Mr. Blackman outlined the development of the idea of scientific planning of towns and cities since the days of Pompeii. His lecture was illustrated by lantern slides and the general trend of his treatment of the subject was the condemnation of the invasion of sky-scrapers into our cities.

CAN. SOC. C.E.—CALGARY.

On February 20th, the Calgary branch of the Canadian Society of Civil Engineers was addressed by F. H. Peters, C.E., Commissioner of Irrigation, the subject of his lecture being "The Georgian Bay Ship Canal." He summarized the advantages and disadvantages of the project now under investigation comparing its estimated value to Western Canada with that of the new Welland Ship Canal and the Hudson's Bay Railway. According to Mr. Peters, the basic principle underlying the advisability of constructing the Georgian Bay Canal was the cost of various kinds of transportation. He outlined the progress that was being made on the Welland Canal and on the Hudson's Bay Railway and explained the movement for the Georgian Bay Canal as being a third project in the interests of cheaper cost of transportation in shipping material in and out of Western Canada.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

AMERICAN SOCIETY FOR TESTING MATERIALS—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

OBITUARY.

We regret to record the death of Mr. FRANCIS S. CLEARY, a young engineer who died on March 24th at Monrovia, Cal. Mr. Cleary was born in Windsor, Ont., 27 years ago. He was educated at Windsor Collegiate Institute, St. Michael's College and Faculty of Applied Science and Engineering, University of Toronto, graduating with the class of 1911. During the past two years he has been employed as an electrical engineer with the Edison Illuminating Company of Detroit.

The death has been announced of F. D. FRIEND, resident engineer for the National Transcontinental Railway at Graham, Ont. Heart failure was the cause. Mr. Friend was a native of Devonshire, England and came to Canada about 10 years ago.

The death was announced on March 18th of DAVID-KEAY McLAREN, president of D. K. McLaren, Limited, Montreal. Deceased was [illegible] years of age.

B. W. FOLGER, president of the Kingston Street Railway, and well known in railway and steamship circles throughout Ontario, died in Toronto last week.

The Great Western Railway Company of England has just placed an order with Herbert Morris, Limited, for the supply of all chain blocks that they require during the year 1914. This is the 13th consecutive yearly repetition of the exclusive use of Morris chain blocks on the Great Western Railway.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21505—March 16—Approving revised location C.N.R. through Sec. 19-2-6, and Sec. 24-2-7, W. 2 M., Sask., mileage 0.00 to 1.43; and authorizing construction of revised line across road between Sec. 19-2-6, and Sec. 24-2-7, W. 2 M.

21506—March 16—Approving plans showing superstructure of eight (8) bridges on 13th Dist. of G.T.R., Province of Ontario.

21507—March 17—Directing that G.T.R., on or before June 15th, 1914, install gates at St. Clair Ave., Toronto, Ont., operates by day and night watchman; 20 per cent. of installing gates be paid by Ry. Grade Crossing Fund, remainder, 1-3 by city, and 2-3 by Ry. Company.

21508—March 14—Directing that G.T.P. Ry., at own expense, make certain changes in highway crossings in Tp. 34, Rgs. 1 and 2, W. 3 M., Sask.; work be completed by May 31st, 1914.

21509—March 16—Authorizing G.T.R. to construct siding into premises of the Chalmers Milling Co., west of Dawes Road, Toronto, Ont.

21510—March 16—Approving G.T.R. plan showing proposed arrangement for lighting vehicular and pedestrian roadways on Victoria Bridge, Montreal; work to be completed within 3 months from date of this Order.

21511—March 17—Authorizing C.N.R. to construct across and divert public road between N.E. ¼ Sec. 33-28-20, W. 3 M., and N.E. ¼ Sec. 4-29,20, W. 3 M., Sask., and divert highway between N.E. ¼ Sec. 33-28-20, W. 3 M., and N.W. ¼ Sec. 34-28-20, W. 3 M., to new crossing, in N.E. ¼ Sec. 33, at station 5684-20.2.

21512—March 17—Authorizing Cedars Rapids Manfg. and Power Co., Montreal, to take additional width of 25.9 ft. for right-of-way for transmission line, making in all a width of 125.9 ft. across Lot 338, Parish St. Joseph de Soulanges, County of Soulanges, Que., property of Archelas Clement.

21513—March 16—Authorizing London and Lake Erie Ry. to connect its tracks with Michigan Central R.R. Co., at west end of city of St. Thomas, Ontario.

21514—March 17—Authorizing G.T.R. to re-construct, subject to condition contained in consent on behalf of Tp. London, overhead bridge carrying highway, known as Westminster Road, between Lots 18 and 19, Con. 1, Tp. London, Co. Middlesex, Ont., over its railway, mileage 121.58 from Suspension Bridge.

21515—March 18—Approving Marconi Wireless Telegraph Co., of Canada's Tariff C.R.C. No. 8, covering new rates for cable letters and week-end letters; said tariff to be filed in form prescribed under Order No. 6679 (General Order No. 32), dated March 26th, 1909.

21516—March 17—Amending Order No. 21417, dated Feb. 27th, 1914, by striking out figures "18903.38" after word "File" wherever they occur in said Order and substituting therefor figures "18903.47"; and striking out figures "131" wherever they occur in said Order after work mileage and substituting therefor figures "161.1."

21517—March 16—Amending Order No. 17400 dated Aug. 30th, 1912, by striking out figures and words, "Lot 31, 0.14" in last line of operative part of Order and substituting therefor words and figures, "Lot 22, Concession 1, 0.72."

21518—March 18—Directing that, on or before April 1st, 1914, C.P.R. restore old clearance by raising under-side of top of culvert eleven inches (bridge over North Branch of the Clyde River, between mileages 24 and 25, just north of Flower Station, Ont.)

21519—March 19—Amending Order No. 21418, dated Feb. 14, 1914, by striking out figures "25" before word "August," where they occur in recital of Order, and substituting therefor figures "29," to read "29th August, 1913."

21520—March 16—Authorizing city of Montreal to construct 8 ft. diameter steel water pipe beneath tracks and across and along lands and right-of-way of G.T.R., upon Lot No. 3410 on Cadastral Plan of Mun. of Parish of Montreal, to be used as Emergency Supply in case of accident to regular water supply for city, subject to and upon certain conditions.

21521—March 19—Authorizing C.N.O.R. to construct trestle to carry its railway across Indian River, Tp. Fraser, Co. Renfrew, Ont., at mileage 101 from Ottawa.

21522—March 19—Directing that C.P.R. stop train No. 22 on flag, daily except Sunday, at St. Clet, Quebec.

21523—March 20—Authorizing C.P.R. to take certain lands situate in Lot 6, Con. 4, west of Hurontario St., Tp. Toronto, Co. Peel, Ont., for purpose of revising and enlarging its station yard at Streetsville Jct.

21524—February 26—Authorizing, subject to terms and conditions contained in agreement, dated June 14th, 1910, G.T.R. to construct siding into premises of Terminal Warehouse and Cartage Co., Limited, west of Common St., Montreal, Que.; and that the Order of Board No. 9859, dated March 9th, 1910, be rescinded.

General Order, No. 123—March 19—Approving form "Release of Responsibility," No. 981, respecting carriage of clothing, wearing apparel, and personal effects (all second-hand), in trunks, securely corded, submitted by C.N.R. That said Form of Release be made applicable to all railway companies under jurisdiction of the Board, until the Board orders otherwise.

21525—March 20—Authorizing G.T.R. to operate sixteen (16) bridges on its 30th District.

21526—March 20—Authorizing G.T.R. to operate trains over bridge carrying 16th District of its railway across Birch Ave., city of Hamilton, Ontario.

21527—March 23—Amending Order No. 19958 by inserting, after item No. 3, following words and figures: "No. 3a. 0.98, Pie LX Street, Railway to cross over highway by means of a bridge, having four openings instead of five, as shown on the said plan, dated 16th November, 1912." That Orders Nos. 16998, 17572, 19286, 19800, 19958, 21414, and this Order, be certified by Sec. of Board and endorsed as provided by Sec. 46 of Rly. Act., and transmitted to Prothonotary of Superior Court in and for Dist. of Montreal, Que.: Provided said Order be without prejudice to rights, if any, to city of Montreal.

21528—March 20—Authorizing C.N.O.R. to take portions of Lots 81 and 82, parish of Ste. Dorothee, Co. Laval, Que., property of Hormisdas Bibault and Onesime Lafontaine.

21529—March 21—Relieving C.P.R. from providing further protection at crossing of Government Road, west of station building at Mortlach, Sask.

21530—March 23—Authorizing G.T.R. to construct 2 bridges—namely, No. 138, mileage 91.90, 17th Dist., nearest Station Woodstock, Ont., and No. 7, mileage 6.15, 15th Dist., nearest station Weston, Ont.

21531—March 21—Authorizing C.P.R. to use and operate Bridge No. 2.65 on its Prescott Subdivision, Eastern Division.

21532—March 23—Amending Order No. 21508, dated March 14th, 1914, by adding following paragraph:—"And it is further ordered that after the completion of the work, the Railway Co., may close the old road allowances across its right of way; the road allowances according to the new survey to be substituted in lieu thereof."

21533—March 23—Approving proposed deviation of Essex Terminal Ry. Co.'s line, as already constructed, between a point near Bedford St., town of Sandwich, Ont., and Detroit River.

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The Canadian Engineer

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CONSTRUCTION OF THE NEW QUEBEC BRIDGE

EVENTS LEADING UP TO THE PRESENT UNDERTAKING—NOTES ON THE COMPLETED MASONRY—ERECTION DETAILS AND POINTS OF SPECIAL INTEREST IN THE SUPERSTRUCTURE.

At a meeting on February 25th, 1914, the Toronto branch of the Canadian Society of Civil Engineers was addressed by Mr. C. N. Monsarrat, Chairman and Chief Engineer, Board of Engineers, Quebec Bridge. On March 2nd, Mr. Monsarrat delivered a somewhat similar address before the Canadian Club of Montreal. His subject at each meeting was a description of the reconstruction of the new Quebec Bridge, and from his remarks the following synopsis is presented:

As early as 1852 a project for a bridge over the St. Lawrence River at Quebec was considered, and again in 1884 a design was prepared and submitted to the Quebec Board of Trade for a bridge at about the present site, but nothing actually was done until about 1900, when the Quebec Bridge and Railway Company located a site near Cap Rouge and took definite steps towards the erection of such a structure. This location is at the narrowest point on the St. Lawrence River between Montreal and Quebec, the width at mean water level being about 2,000 feet. The water at this point has a maximum depth of about 200 feet and a current at ebb tide of about 7 miles per hour. The Bridge and Railway Company awarded contracts in 1900 for a bridge of the cantilever type having a main span of 1,800 feet. Work was started and proceeded until the year 1907, when about half the superstructure, then erected, collapsed. Soon after this lamentable disaster the Dominion Government undertook to reconstruct the bridge, and in 1908 appointed a board of three engineers for that purpose. This board made very exhaustive studies of various designs, including suspension and cantilever bridges, and finally decided, for good and sufficient reasons, that the cantilever type of bridge was the most satisfactory and economical kind of structure for such a crossing. It also decided that the bridge should be much wider and designed for heavier loading than the former bridge, that the same length of main span should be retained and that it should be built at the same site. Several changes were made in the personnel of this Board during the progress of the work, and since the contracts were let the Board has been composed of Mr. Ralph Modjeski, Mr. C. C. Schneider and Mr. Monsarrat, who is chairman and chief engineer.

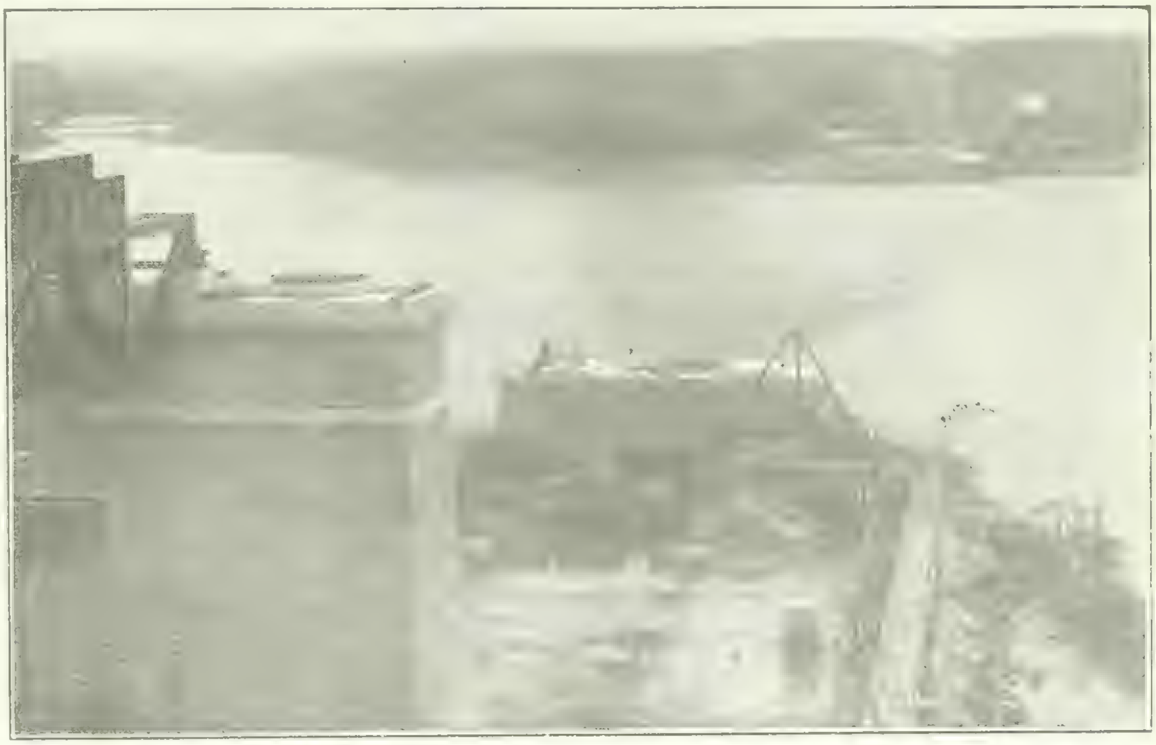

Fig. 1.—General view of the bridge site from the north shore, showing the completed masonry on both sides of the river.

Among the first things to be done in connection with the reconstruction was to take an extensive series of borings to ascertain the nature of the bottom and locate

bed rock. The latter was found to exist about 100 feet below high-water. It was also decided that the old masonry was not large enough to suit the new structure and it was therefore demolished and entirely new piers built.

The clearing away of the debris of the fallen structure was a somewhat difficult task, but it was finally accomplished by the aid of the oxy-acetylene torch and dynamite. At the present time there is little or no evidence to show that this accident had ever happened. There still remains, however, about 10,000 tons of the old bridge at the bottom of the river extending out from the shore over 800 feet. Tied down by this wreckage are the remains of some 60 or 70 men who lost their lives when the accident took place. As the water at this point is very deep and the wreckage is far below the requirements of navigation, this steel will probably remain for all time in its present location, as there is no known method of salvage at the depth at which it lies.

The most serious problem in the construction of the masonry was the sinking of the pneumatic caissons for the two main piers. On the south side a single caisson 180 ft. x 55 ft. in area was used. On the north side two caissons each 80 ft. x 60 ft. were sunk with a 10-ft. space between them, the pier being bridged over this opening. No serious difficulty was met with in the sinking of these caissons although the material on the north shore was very much harder to penetrate than that of the south.

The completed main piers at the present time, extending as they do about 25 ft. above the water, do not give evidence of the enormous amount of labor expended in their construction. As the north pier was driven 60 ft. and the south pier 100 ft. below the bed of the river, at a cost of approximately $1,000,000 each, some idea of their enormous proportions may be obtained.

The anchor piers show up more prominently, being entirely above high-water. These piers are 136 ft. long and 29 ft. wide and extend about 140 ft. above the surface of the ground, or higher than a 10-story office building.

The span of the Quebec Bridge is 1,800 ft. between main piers—the longest of any bridge in the world—being 100 ft. longer than that of the famous Forth Bridge in Scotland. The length of the suspended span is 640 ft., and the total length between abutments, 3,239 ft. The bridge has a clear height of 150 ft. above extreme high-water for a distance of 500 ft. at the centre of the bridge, in order to allow passage of ocean ships beneath. The bridge is 88 ft. wide centre to centre of trusses, or 21 ft. wider than the old bridge. The height of the main posts over the main pier is 310 ft., with an unsupported length of 145 ft. These posts weigh 1,500 tons each, the four of them costing in the neighborhood of $1,000,000. The height of the bridge above the floor at the main piers is about 180 ft. Some idea of the enormous proportions of this bridge may be gathered from the fact that a 16-story building could rest on the floor at this point and hardly extend above the tops of the main posts.

The steel shoe or pedestal carrying the main posts and other members on the main pier has a base with an area of approximately 22 ft. x 26 ft. It is 19 ft. high and weighs about 400 tons. The total reaction on each of these shoes amounts to 55,000,000 lbs. Some idea of this enormous force may be gathered from the fact that it represents the weight of 150 standard locomotives. If these locomotives were placed one upon the other they would extend to a height 15 times that of an ordinary 10-story building.

The bottom chord of the bridge weighs approximately 400 tons between main panel points. This has to be shipped in four pieces for shipment and handling during erection. The outside dimension of this chord near the shoe is approximately 7 ft. x 10 ft. 6 in. If it were not for the interior diaphragms and bracings, it would be possible for six or seven men to walk abreast throughout the length of this member.

Fig. 2.—View showing one web of double floor beam at the bridge site storage yard. These girders are 10 ft. high and 88 ft. c. to c. 11-inch pins are used to connect the 60-ton floor beams to the post.

The main post, as stated before, is 310 ft. high. It is approximately 9 ft. x 10 ft. in outside dimensions, and has an area of 1,902 sq. in. It is composed of four columns laced together, and requires to be shipped in 27 pieces and connected together in the field. The weight of the bridge will amount to about 65,000 tons, which weight exceeds that of the 200 bridges constructed on the National Transcontinental Railway. These bridges, if placed end to end, would extend over a distance of 11 miles. This weight is also about five times that of the new double-track C.P.R. bridge over the St. Lawrence at Lachine.

A proportion of the steel used in the bridge will be nickel steel, 40 per cent. stronger than the ordinary carbon steel used in other bridges. This nickel steel is used principally near the centre of the bridge where the weight is the greatest factor in deciding the size of the members.

The bridge is designed to carry two railway tracks, capable of carrying two trains weighing approximately 5,000 lbs. per lineal foot each. There are also two sidewalks for foot passengers. No provision has been made for highway traffic.

New shops have been constructed by the St. Lawrence Bridge Company, exclusively for the manufacture of this bridge, with special equipment and handling machinery, the whole costing in the neighborhood of a million dollars.* Up to the present some 9,000 tons of material have been manufactured and shipped to the site.

During the past season the contractor for the superstructure has got his plant in shape and has already erected the two north approach spans from the abutments out to the anchor pier. It is expected that during the coming season practically the whole of the north anchor arm will be erected.

The erection of this bridge is probably one of the greatest problems, calling for more engineering skill than any other structure of its kind in the world. Every feature of erection from the placing of the members to the driving of the rivets is worked out in detail, and is supplied in printed form in a bound book to the erecting superintendent. All engineering problems are therefore solved for the erection force before they start, their duty being simply to carry out the mechanical end of the work in accordance with positive instructions. To handle the huge members on the bridge itself during erection, enormous steel travellers will be used, one on each side of the river, each of which, with its machinery, will weigh over 1,000 tons. One steel traveller is at the present time nearing completion on the north shore. All the cranes and derricks on this traveller. are operated by electricity. The traveller runs on trucks and is moved from point to point on the floor of the bridge as the work progresses. This derrick is capable of lifting 55 tons on a boom 50 feet long. Everything about the mechanism and machinery has been made as nearly foolproof as possible.

In order that there may be no possibility of these heavy members being dropped and doing damage to the bridge or endangering lives, it is necessary to operate the hoisting engines against an electric resistance which means that the engines have to work just as hard to lower a piece as is necessary to raise it. Some idea of the size of the tackle used may be gained from the fact that the large blocks employed are about 5 feet in height, and weigh approximately 5,000 lbs. each.

One of the features of the erection which will probably be unique in the annals of bridge engineering will be the floating in of the centre or suspended span. This span will weigh about 5,000 tons and will be erected on trestles at some point near the bridge. When it is ready to be floated, very large pontoons will be floated under the span at low tide and when the tide rises will lift the entire span off the blocks. It will then be floated into position under the two ends of the cantilever arms at a low level and be connected up to these arms with long steel links. During this operation all navigation will be stopped in the river. When the connection has been made at the four corners at extreme high tide, the barges will settle with the tide and leave the span suspended. Powerful jacks of 2,000 tons capacity, situated at each corner of the cantilever arm, will then be brought into play and this span lifted slowly into place. It is estimated that the connecting up of the span should not take over an hour under good conditions and the span itself should be lifted into its proper position in about 48 hours.

Fig. 3.—View of one end of main bottom chord in twin vertical facing machine which faces both ends simultaneously. This chord is a ½-panel length and is shipped in two pieces. Fig. 4.—North shore traveller in course of erection. It is 200 ft. high and will weigh over 1,000 tons. Fig. 5.—One full panel length connected up for the reaming of the splice plates. The member, as it stands, weighs 400 tons. The heavy gusset plates taking a vertical tension and diagonal compression member is shown at one end.

The erection of the suspended span in this manner will save about one year in the time required for the complete erection of the bridge.

It is expected that the bridge will be sufficiently completed to allow traffic to proceed over it by the end of 1917.

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*For full description of these shops see *The Canadian Engineer* for January 22nd, 1914.

There are many interesting features worthy of note in the shops of the St. Lawrence Bridge Company, mentioned elsewhere. Among the accompanying illustrations

Fig. 6.—North approach span erected. As the railway tracks on the bridge are 32 ft. centre to centre, these approach spans are erected as two separate bridges, each carrying a track.

there are several which convey a slight idea of the size and weight of some of the bridge members which these shops are turning out. Their proportions greatly excel

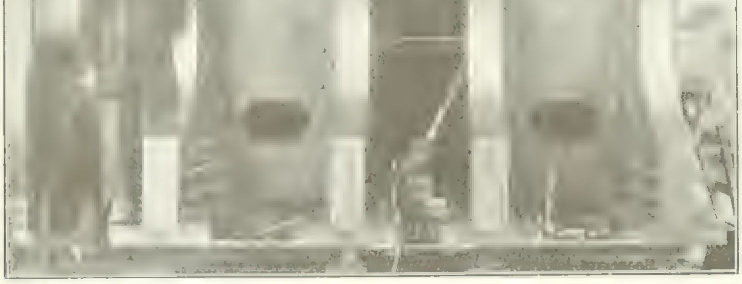

Fig. 7.—End view of member shown in facing machine. This end is bored for a 45-inch pin sleeve, which takes a 30-inch pin weighing 12 tons. Each of the webs are 7 inches thick at the pin. Manholes are provided at all diaphragms to allow contractors, painters, etc., to reach every portion of each member.

those of the product of any other shop removed any distance from the site. Moreover, the special machinery with which the plant is equipped for the rapid and accurate machining of special designs is in itself remarkable in its massiveness and adjustments. Among these various machines are the two planing machines, manufactured by James Bennie and Sons, Glasgow, with a capacity for plates up to 46 ft. in length. In them the heavy sheared plates have their edges finished, the cutting tools operating on both forward and return strokes.

The drilling and reaming are carried out on 16 stationary 7-foot radial drills, made by the Canadian Machinery Company, and 24 portable drills, transferred by cranes from one place to another. Shop rivetting is done for the most part by pneumatic yoke machines of 100 tons capacity.

A vertical boring mill manufactured by John Bertram and Sons Company, is used for boring large pin-holes and oval manholes. These large pin-holes, up to 4 ft. in diameter, are then finished in a horizontal boring machine with horizontal and vertical motions sufficient to permit the finishing of five of these pin-holes without resetting.

GRAND RIVER IMPROVEMENT.

SINCE the publication of the preliminary report of the Hydro-Electric Power Commission of Ontario on a proposed scheme or artificial storage and flood control on the Grand River, an exhaustive study of the flow characteristics of the river and its tributaries has been under way. The preliminary report appeared in *The Canadian Engineer* for April 17th, 1913. According to the 6th annual report of the Commission the investigation was begun in June, 1913, and at the present time gauging stations are established on the Grand River, and gauge recorders employed at each station to take readings of water level twice a day. This work has now been carried through one low-water season and some valuable information obtained. There has so far been a reasonably close relationship between gauge height and discharge. This satisfactory relationship has been mainly the result of low-water conditions, and there is unfortunately no likelihood that similar conditions will obtain during high stages of flow, when the gauges will be unavoidably affected by backwater.

In anticipation of the effect of back-water upon the gauges, a line of levels was run up the Grand River valley as far as Bellwood, and for several miles up each of the main tributaries. The work was started at Dunnville, using the U.S. Lake Survey level of Lake Erie as a datum. Permanent bench marks referred to sea level were established at convenient intervals on the main stream and tributaries.

During the course of the work all accessible Geodetic Survey bench marks were picked up, and in every case a very satisfactory check was obtained. A reasonable check was also obtained on various railway elevations.

All the gauges from which water level readings are being taken on the Grand River and tributaries are set from these bench marks, consequently all gauges are set to the same datum throughout the watershed, and slope data can be taken directly from the gauge readers' records. With the help of this slope data it is hoped that it may be possible to apply corrections to the gauge readings during high stages of flow, and thus eliminate to a large extent the effect of back-water.

THE MANAGEMENT OF SEWAGE DISPOSAL WORKS.

IN a paper which he read last month before the Institute of Sanitary Engineers at Westminster, Eng., Mr. John E. Farmer, engineer-in-charge of the sewage disposal works of the town of Croydon, presents the following notes on the operation of disposal works:

The works manager should look at the disposal of sewage in the light of a manufacturing process—the sewage discharged on to the works being the raw material and the final effluent the finished product. With regard to the financial aspect, a manufacturer must part with his finished product at a price that is greater than the cost of his raw material plus expenses of manufacture. With sewage disposal the raw material may be taken as being delivered to the works free of cost, and, there not being, except in a few cases, any saleable product, there is only the cost of manufacture of the final effluent to be taken into account.

There are two things to consider in the improvement of sedimentation tanks, i.e., the reduction of the amount of suspended matter in the tank effluent of the present designs, or to increase the volume now treated by the same tank capacity without increasing the solids in suspension, as now obtained. The former would lessen the work to be done by the process which follows, and the latter would save tank construction.

By placing a fine screen, such as 3/32 in. perforated zinc, between the tanks and the filters, it will save about three-quarters of the labor in cleaning the holes of the sprinklers, where such are in use, and also save much treading on the surface of the filter.

During a portion of the year there is some of the irrigation area fallow. The efficiency of fallow land is about one-third that of grass-cropped land where broad irrigation is the method; but where land filtration is in vogue the effect of a fallow period is not so great.

With an up-to-date plant for the purification of the liquid portion there are the solids to be dealt with; these have been a source of much trouble ever since sewage disposal was first put into operation.

The solids screened out and that deposited in the grit chambers are easier to deal with than the sludge, as they contain less moisture, and thereby more easily disposed of.

At Croydon all the solids are disposed of on the land—the screenings and grit by cart or trucks, the sludge by pumping—all being spread and ploughed in as manure. Lime is added to the sludge before pumping to reduce the smell and to accelerate the decomposition of the organic matter. The addition of 0.5 per cent. of lime reduces the smell about 75 per cent. The ratio of screenings and grit to sludge is 1 to 11.75, both in their wet state, or 1 to 2.8 in the dry state.

In the management of a sewage disposal plant, irrespective of the method of disposal, there should be kept records of all the different items showing the work done, thereby not only giving the present position, but enabling comparison with the past and information for the future.

The most valuable method of keeping the records is by diagrams. The usefulness of this method far outweighs the time and labor required to plot them, as the information for comparative purposes, so essential in tracing the cause and effect, which many times arises in the disposal of sewage, can be seen at a glance.

The main items for recording are: Volume of sewage and amount of rainfall; quality of sewage and effluents; amount of screenings, grit, and sludge; number of units working of the different parts of the process of purification; also the cost in wages, say, of the sludge disposal; irrigation; pumping, etc.

In keeping records there is obtained information that is of value not only to the management, but to the engineer in designing new extension works.

Combining the record of the hourly flow and the oxygen absorbed in four hours of samples taken each hour, one is able to find between which hours the greatest amount of impurity, as indicated by the above test, has to be dealt with.

Last, but not the least, item in the management of sewage disposal is the finding by observation and research the means of improvement in the present methods of purification, and also for the cause of the effect obtained.

Some work in this respect which I have done may be of some interest.

It has been known for years that a filter of fine-grade material gives better results in purification than one of coarse grade. Also some materials give better results than others. But there has not been, to my knowledge, any work done to definitely settle the cause of these differences.

One difficulty has been the want of means to measure the physical properties of the different materials used as a nidus for the bacteria. If this could be overcome, the point could be settled as to whether the cause of the difference between two different materials, when used as a nidus was due to greater absorptive powers of one than the other, or to greater surface area. The former used to be given as the reason by many a few years ago, but I think the latter is generally recognized as the reason at the present time.

To find the purification given by clinker as a nidus in a filter, as compared with gravel, a filter was constructed in two halves, one-half filled with clinker and the other half with gravel, in 1904, at Croydon.

The grading being the same for both materials, i.e., drainage tiles and 3 in. gravel = 9 in.; ¾ in. to 1 in. = 1 ft.; ¼ in. to ¾ in. = 3 ft. 3 in.; total, 5 ft. Area, 200 square yards; rate of working, 200 gallons per square yard per 24 hours. Fed by revolving sprinkler.

The average results of 31 samples taken between October 13th, 1904, and June 19th, 1905, are:—

	Tanks' Effluent.	Clinker ½.	Gravel ½.
Free ammonia as nitrogen..	5.747	0.665	4.148*
Albuminoid as nitrogen	0.360	0.068	0.166*
Oxygen absorbed, 4 hours..	4.157	0.914	1.843*
Chlorine	9.43	9.14	[illegible].71
Nitrates as nitrogen	—	4.529	1.265*
Nitrites as nitrogen	—	0.165	0.294*
Dissolved oxygen	[illegible]	5.8	[illegible]

*Parts per 100,000. †C.C.S. per litre.

The above results show that clinker gives much better results than gravel; but the question is, What is the cause of this?

To find the reason, I have carried out some experiments in the laboratory.

As regards the reduction of the impurity by passing over the surface, there must be taken into consideration that as the water passes downwards it gradually becomes less impure, so that after [illegible] surface

area it gives to the next a water which has less impurity than it received, so it is quite obvious that the same per cent. purification cannot be effected by the second area of surface, assuming they have both the same surface area.

From the experiments made one comes to the conclusion that the surface area of the material is the factor which governs the comparison between one material and another as regards its suitability as a nidus in a filter.

It may not be out of place, especially as I have mentioned it before, to give the physical property of materials for absorbing salt. During my experiments to obtain a method for estimating the surface retention, I found that all materials experimented upon absorbed a considerable amount of salt, and by extending the surface retention method this absorption could be estimated.

The following is a summary of the results: That with both clinker and gravel the amount absorbed per cube foot increases regularly with increased diameter of the particles. If this property was the cause of the difference in purification, as many believed it was, the purification would increase with the increase in size of the material; but the reverse has been shown to be the case. The management, after obtaining an effluent, has to observe its effect on the stream into which it is discharged, and there is a great probability that in the near future this will be one of the management's most important observations.

MINERAL PRODUCTION IN QUEBEC FOR 1913.

Substance.	Production, 1913. Quantity.	Value.	Value in 1912.
Asbestos, tons	136,105	$3,825,959	$3,059,084
Asbestic, tons	28,371	20,245	23,358
Copper and sulphur ore, tons	80,345	866,774	631,963
Feldspar, tons	74	1,554	2,200
Gold, oz	738	14,704	19,924
Graphite, tons	103	9,620	50,680
Iron ore, bog, tons	......	......	......
Iron ore, titaniferous, tons	4,081	9,824	4,024
Kaolin, china clay	253	4,354	520
Magnesite	......	......	9,645
Mica, lbs.	781,648	117,038	99,463
Mineral water, gals	77,313	31,728	30,854
Ocher, tons	5,087	40,868	32,010
Peat	......	......	2,000
Phosphate, tons	360	3,506	1,640
Quartz and Phonolith, tons	900	2,363	418
Silver, oz.	36,392	21,701	14,501
Zinc and lead ores, tons	335	7,370	....
Structural Materials.			
Brick, M	156,358	1,272,092	1,284,232
Cement, barrels	2,881,480	3,[illegible]	3,098,350
Flagstone	......	......	600
Granite	....	482,338	358,740
Marble	......	120,541	252,041
Lime, bushels	1,656,610	452,330	455,570
Limestone	.....	1,570,455	1,363,555
Sand	....	343,750	170,600
Sandstone	......	5,072	....
Slate, sq	1,337	6,286	8,030
Tile, drain and sewer pipe, pottery, etc.	...	326,165	203,10[illegible]
		$12,918,1[illegible]	$11,1[illegible]

There has been in recent years a steady increase in the amount of brick pavement laid in Rochester, last year's total being [illegible] square yards. However, the amount of asphalt pavement is still greatly in excess of any other kind. In 1913, 146,524 square yards of street asphalt were laid, while 121,700 square yards of creosoted wood-block pavement were laid in Manhattan borough, 20,000 square yards in Peekskill, and much smaller quantities in other boroughs.

REPORT ON COLLECTION AND DISPOSAL OF WASTE, TORONTO.

The Street Commissioner of the City of Toronto, Mr. Geo. B. Wilson, has recently presented a report on the collection and disposal of the city's refuse, together with a number of recommendations in connection therewith. The report has received the approval of the Medical Officer of Health for Toronto, and the Chief Health Officer of Ontario. In this report, it is assumed that the term refuse includes garbage, rubbish, and ashes; that the term garbage includes all kitchen refuse; and that the term rubbish includes all household waste other than ashes and garbage.

A summary is given as follows: It is recommended that the city construct a combined central plant at Ashbridge's Bay, where all garbage will be disposed of by the reduction process, and all rubbish incinerated in high-temperature furnaces. The power which is developed from the rubbish furnaces will be utilized in the reduction plant, and the gases deodorized.

An analysis of the studies made demonstrates that the disposal of garbage by reduction becomes more advantageous in future years, as compared with other methods of disposal.

The reduction method for the disposal of garbage requires a larger capital cost, but with all items considered, will require a much lower net annual cost.

All work contemplated will be developed on a comprehensive scale, and with reference to future needs.

The development of any method for collection and disposal of refuse should also consider all branches of work carried on by the street cleaning department, with special attention to operation and unit cost-keeping.

The equipment used in collection of refuse should be installed with special regard to work to be done, from the standpoint of sanitation and economy.

All refuse, so far as possible, should be removed from the premises (and not placed on the curb), so as to eliminate the unsightly appearance of streets on collection days.

In making separate collections of refuse, co-operation will be required on the part of the citizens, as well as the strict enforcement of regulations by the department of street cleaning.

It is recommended that the condition of the present stables, yards and shops should be remedied by the construction of adequate buildings, to enable the department to satisfactorily conduct all branches of the work.

Early action is desired, to relieve the present conditions.

The question of garbage and refuse disposal received considerable attention at the hands of Mr. R. C. Harris during the period in which the service was under his control. It was reported upon by him in 1912 and as a result a by-law was passed in January, 1913, authorizing the expenditure of $1,000,000. The matter remained in abeyance, however, until the reorganization of the present department in May, 1913. Since that time, Mr. George B. Wilson, Street Commissioner, realizing the importance of the step to be dealt with and the necessity of an early solution, has given the problem a thorough investigation. In October, 1913, he acquired the services of Mr. I. S. Osborn, an engineer experienced in the methods of collection and refuse disposal as practiced both in America and Europe. Since that time Mr. Osborne and his staff have prosecuted the necessary preliminary investigation without interruption.

The problem of waste disposal naturally involves, among other things, a complete study of the methods and costs of collection, the equipment required for such collection, and the population to be served in the different sections of the city at various periods. Recognizing that the solution of the refuse problem in itself would only afford a partial relief from the conditions which prevail throughout the city it was decided to include in the investigation a study of present stable, shop and yards requirements as well as studies of collection methods and equipment.

Concerning the methods of collection the report makes the following reference:

Collection Methods.—Great advance has in recent years been made in this manner of collecting waste in many of the European cities, and so far as possible, such changes as are to be made in the collection methods of the department, will be carried out with the idea of eliminating the undesirable features, which at present obtain. The methods of collection adopted will depend on the conditions to be met, and will necessitate considerable study and practical experimenting. This can only be undertaken when the method of disposal has been definitely determined.

Irrespective of the manner of disposal adopted, it will be necessary to continue to dispose of ashes as at present, viz., as filling for low lands. This being the case, the cost of collecting ashes will remain constant, and has, therefore, no bearing on or influence in determining the method most advantageous in the collection and disposal of other classes of waste.

The points to receive attention are as follows:

(1) The removal of waste from the premises in such manner as to eliminate the unsightly appearance of the streets on collection days, where receptacles are placed on the curb and remain there during the day.

(2) Type of equipment used in collection to be such as will prevent the scattering of material on the streets, and the creation of dust when contents are being discharged from receptacle into wagon.

(3) The improvement in type of receptacle; the ideal condition being, of course, a standard container.

(4) The development of collection methods from a sanitary and economical standpoint. (The greatest cost in making collections results from the time required to load, due to equipment remaining idle while material is being picked up.)

When disposal is made by incineration, a combined collection of garbage and rubbish is usually made. This requires the householder to provide a receptacle for the material in a combined state, and relieves the tenant of the trouble of making a separation at the house.

If disposal is made by the reduction method, it will require the householder or tenant to keep garbage entirely separate from rubbish.

It must be borne in mind that in changing from a combined collection of garbage and rubbish, to a separate collection, separate collection wagons for each class of refuse, as well as separate containers for each class, will be required.

Unless there be hearty co-operation on the part of householders, and they are educated to render assistance, it will be difficult to obtain the desired results, since without proper separation, the costs of reduction will be increased, and with a combined collection the reduction of garbage will be positively prohibitive from a practical standpoint. The adoption of this method will mean the strict enforcement of regulations governing garbage collections on the part of this department.

Climatic conditions tend to make separate collections in Toronto difficult, as during the winter months, unless well drained, garbage will freeze in the containers, though with due care in the draining of garbage before it is placed in the container, and the use of paper, this may be eliminated to a very large extent.

When garbage is mixed with rubbish, it is necessary from a sanitary standpoint to make more frequent collections, whereas with separate collections, a more frequent collection of garbage could be made if deemed advisable, and a less frequent collection of rubbish.

When separate collections are made, a wagon having a much larger capacity than our present carts, can be used to advantage for the collection of rubbish, the size being limited to a wagon that can be handled in the places where collections must be made.

It is the intention of the department to experiment with what is known as the "Roller System," whereby cans are brought from the house to the curb by men in advance of the collection wagons, and, after the material has been placed in the wagon, the empty cans are returned to the premises by men who follow up. It is expected that this will permit of the more satisfactory and expeditious loading and removal of the material.

It has been assumed by the department in its estimates of costs that the present practice of requiring the householder to place the receptacles on the curb will be done away with, and that all collections, where possible, will be made from the premises. This will eliminate the unsightly appearance of the streets, due to the fact that receptacles frequently remain from morning until night on the streets on collection days. It will, however, relieve the householder of the trouble of placing the can on the curb and returning same after its contents have been emptied.

Costs of Collection.—In estimating the cost of collection, many items will of necessity have to be considered, such for example as the type of equipment used, and the advantage of the same as to loading and unloading; the size of the wagon used in making collections for each class of material, and the maximum load of each class of material which can be economically placed on each wagon.

The costs will vary under different conditions, with the different types of equipment used. For example, the cart which is now in use will permit a man to load the material at a less cost per ton than the same work could be done by one man using a team and wagon. This is due to the increased cost of the team and wagon over the one horse and cart.

The productive cost of the man and cart as now operated by the department, amounts to approximately \$4.33 per day, while the cost of the team and wagon, with driver, amounts to \$5.83.

One man will load as much material per hour on to a cart as he will on to a wagon, so that the cost of loading, under similar conditions, increases where the wagon is used, but as the wagon will hold considerably more material than the small cart, if of proper capacity, the cost per ton mile will decrease in proportion to the weight carried. For example, the material can be placed on the cart at a less cost per ton than it could be placed on the wagon (both remaining idle meanwhile), but with increased capacity of the wagon, the quantity hauled by it will decrease the cost per ton mile [illegible]. It is, there-

fore, obvious that with any great distance to be travelled, the wagon will show a considerable saving, due to its larger capacity.

In this connection, it must be evident to all citizens that the carts at present in use by the department are taxed beyond their capacity, and are thereby rendered unsightly in appearance in collecting from house to house and travelling our public thoroughfares. It must also be evident that before the load can be collected, and the canvas placed on the cart, more or less of the material is scattered on the streets, thus rendering them untidy, particularly in the residential sections, and throwing an extra burden on the street cleaning section of the department.

As already stated, the type of equipment to be recommended for adoption will, to a great extent, depend upon the method of disposal determined, and so soon as convenient after this question has been settled, studies will be made, using various types of equipment for collection by various methods, with a view to installing that which is found to be most suitable from a sanitary and economical standpoint.

Methods of Disposal Considered.—(1) Total incineration of all rubbish and garbage, and such quantity of ashes as required for their fuel value, the bulk of the ashes being disposed of as fill; and (2) Total incineration of rubbish, and reduction of garbage, with ashes disposed of as fill.

The results of the studies made were applied to twelve projects, assuming possible locations of disposal plants or loading stations for the transfer of refuse to a central plant by steam railways, electric trolleys, or motor trucks.

In considering the method of total incineration in high-temperature furnaces, the combustion gases, where possible, should be used in generating power, but due to the price at which electric current is furnished by the Hydro-Electric Commission, it is not feasible to generate electric current from power that can be developed in the refuse furnaces, since to do so would not warrant the additional first cost of installation, or increased cost of operation. It has not been possible to find any outlet for the utilization of steam, inasmuch as at such locations as the quantity produced might be profitably utilized, the demand would not be constant. Again, where the demand would be constant, suitable sites are not available for the installation of furnaces.

Of the 12 projects investigated, 3 of them appearing the most feasible are summarized in the report according to the accompanying table.

The report recommends the adoption of project "C" which provides for the total incineration of rubbish and reduction of garbage in a combined central plant erected at Ashbridge's Bay, the material to be transferred thereto from three loading stations in the western, northwestern and northern sections of the city.

It is proposed, under the method of disposal recommended, to have all material collected delivered to the loading stations, and thence transferred either by steam railway, electric trolleys, or motor trucks, to a central disposal plant located at Ashbridge's Bay, except the rubbish and garbage collected in the territory adjacent to the central plant, which will be delivered by the collection wagons direct. The garbage will all be scientifically treated in a reduction plant, the rubbish incinerated, and the power developed from the rubbish furnaces used in operating the reduction plant, the high temperature produced being utilized to deodorize the gases.

The central plant at Ashbridge's Bay (assuming the adoption of the department's recommendation), will consist of an unloading building, in which all garbage delivered at the plant will be unloaded. All handling of material as delivered will take place in this building. The garbage from the unloading building will be delivered into reduction machinery in the reduction building, where it will be broken down by heat in enclosed equipment, and not exposed until thoroughly sterilized.

The free grease and water will be separated from the solids in the reduction building, the solids being delivered to drying building, and the water and grease to the grease separating building. The grease will be separated by gravity from the water, and the remaining

Summary of Three Proposals.

Project.	Capital cost.	Collection			Disposal			Fixed charge	Revenue			Net Annual Cost		
		1913	1918	1923	1913	1918	1923		1913	1918	1923	1913	1918	1923
A—Total incineration of all garbage, rubbish and part of the ashes, in two, three or four disposal plants.	$480,000	143,061	199,443	280,870	64,145	85,863	114,953	37,056	None	None	None	244,262	322,362	432,870
B—Total incineration of rubbish in two incinerators, and reduction of garbage outside city	$676,000	180,563	264,667	368,707	127,422	150,437	206,110	52,187	159,492	213,468	285,637	200,680	253,823	311,307
C—Total incineration of rubbish and reduction of garbage in central plant located at Ashbridge's Bay.	$720,000	173,081	240,531	341,887	112,164	149,007	193,502	55,584	159,492	213,468	285,637	181,037	231,654	305,346

water concentrated by evaporation, to recover the solids that are held in solution, and which in turn will eventually be dried with the other solids to produce a by-product, known as tankage.

The solids as delivered from the dryers in a dry state, will be delivered to the extraction building, where recovery of remaining grease will be made by a solvent.

By the treatment described, all solids originally in the garbage will be recovered, as tankage and grease, and ready for sale or shipment.

The rubbish will be delivered to incinerator building, where it will be burned. The furnaces for this purpose will be connected with boilers, so as to develop steam to be used in reducing the garbage. In addition to the boilers installed for generating steam from rubbish, boilers will be installed for use of coal to supply such additional steam as may be required to complete the process of reduction.

During the operation, all material, so far as possible, will be sealed during the process of disposal, and the gases and steam trapped, so as to pass them through deodorizing scrubbers, and such gases as are not deodorized in the scrubbers, will be exhausted and passed through the rubbish furnaces, where they will be deodorized by being subjected to a temperature of from 1,200 degrees to 2,000 degrees F. It is also intended to exhaust the air from rooms which might contain odors, and to utilize the air so exhausted to supply a draft on the rubbish furnaces.

A SHORT LINE FROM THE MARITIME PROVINCES TO THE QUEBEC BRIDGE.

Surveys have been completed for the construction of what will be known as the Quebec Extension Railway to run from Washburn, Me., through a distance of 110 miles in the State of Maine and 64 miles into the Province of Quebec. The intention is to ultimately continue the road to the Quebec Bridge, connecting there with the transcontinental roads from the west and furnishing a short line from it to the Maritime Provinces. The line will be operated throughout by electricity.

Another electric line, the Aroostook Valley Railway, runs from Washburn, Me., and will afford connection at Presque Isle, Me., with the Canadian Pacific Railway to St. John, N.B.

Mr. S. B. Wass, assistant chief engineer of the St. John and Quebec Railway, is chief engineer of the new project. From him we learn that the construction of the line will include two large bridges of approximately 600 ft. in length over the St. John and Alligash Rivers, and also an 80-foot bridge at Beaver Brook. The Canadian Eastern Construction Company, who have been awarded the contract, will likely begin operations during the coming summer.

The C.P.R. owns or controls 18,000 miles of railway. Its own system is comprised of 13,280 miles, and the Minneapolis and Duluth roads account for some 4,000 miles of track. It has still about 700 miles of spur lines and extensions to build in the west; while the double tracking will mean an addition of over 4,000 miles of railway.

The state of Minnesota has attained a position in the first rank as far as road improvement is concerned. In 1914, the state will spend $2,5[illegible] upon roads and bridges, and will inaugurate a system of road patrols for the maintenance of its roads. Nearly 1,500 patrolmen will be assigned to 5 and 8-mile sections of the state highways, and will be held responsible at all times for the condition of the roads.

GRAPHICAL SOLUTION OF THE THREE-POINT PROBLEM.

A GRAPHICAL method of solving on the plane table the three-point problem in hydrographic surveying was given recently by Mr. A. L. Higgins in "Engineering," of London, Eng. His solution is the extension of the well-known method of "two intersecting circles," and is outlined as follows:

Problem.—Given a, b, and c, the plotted positions of three points A, B, and C, and θ and ϕ, the angles subtended at P by A B and B C respectively; to determine p, the position of P on the map (Fig. 1).

Solution.—From b draw lines b e, b f, making the angles a b e, c b f respectively equal to 90 deg. — θ and 90 deg. — ϕ. At a erect a perpendicular to a b, intersecting b e at e; at c erect a perpendicular to b c, intersecting b f at f. Join e f. Let fall a perpendicular from b on e f; this will meet e f at the required point p.

Proof.—On e b and e f as diameters (centres o and o' respectively) describe circles; these will intersect at p, the common apex of two adjacent angles equal to the observed angles θ and ϕ. For, being angles in the same segment of a circle, the angle a e b is equal to the angle a p b, and the angle c f b is equal to the angle c p b. And the angle a e b is by construction equal to θ; therefore the angle a p b is equal to θ. Similarly, the angle c p b is equal to ϕ.

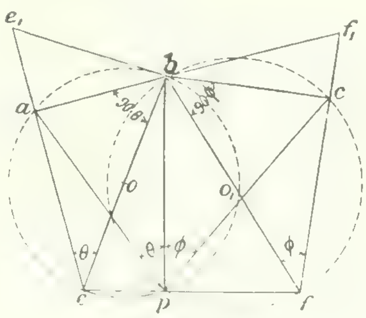

Fig. 1.

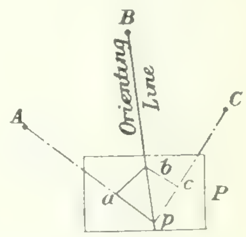

Fig. 2.

The above construction is more expeditious in the office than the one from which it is derived. It is readily effected on the plane table in a manner hereafter described.

The Analogous Plane-Table Problem.—Given a, b and c, the plotted positions of three visible points A, B and C, to determine p, the plotted position of P, the station occupied by a plane table.

(This notation is retained throughout the remainder of this article.)

Here the angles θ and ϕ (Fig. 1) are involved graphically, but the fundamental principle of the plane table precludes the necessity of observing their magnitudes.

The "three-point problem" involves the dual process of

1. "Orientation"—i.e., setting the board so that the several plotted lines are parallel to, or coincident with, the directions of the corresponding lines in the field.

2. Plotting p, the position of the station occupied. (This is a separate process (resection) in the case of Bessel's graphical solution.)

Although possessing the same characteristic—that of plotting the station occupied—this problem cannot appositely be termed a special case of resection, since the application of that method pre-supposes direct means of orienting the board—a ray drawn in the direction of P

at a previous set up over one of the three points A, B, or C.

Thus, for an example of resection, suppose a surveyor has a plane table oriented over B, and a picket at P to indicate a station selected for detail work. Before removing the table he draws a ray through b, the plotted position of B, in coincidence with the line B P, as a direct means for orientation at P. The required point p is somewhere in this ray. He then sets up over P, and orients the board by sighting at B, with the fiducial edge of the alidade along the ray through b. The board oriented and clamped, he determines p at the intersection of the line sighted through a to A with the ray through b to B. As a check he would centre the fiducial edge on c, sight at C, and note if the line thus drawn also passes through p (Fig. 2). But, as far as the three-point problem is concerned, the three points are virtually inaccessible; direct orientation is therefore precluded, and resort must be made to one or other of the mechanical, graphical, or trial solutions.

Some years ago the writer observed that the extended hydrographical solution (Fig. 1) might be readily adapted to the analogous plane-table problem, with special application to cases in which the angles subtended at P by the points A, B, and C, were large, and, in consequence, frequently necessitated additional construction in the application of Bessel's method. Not only

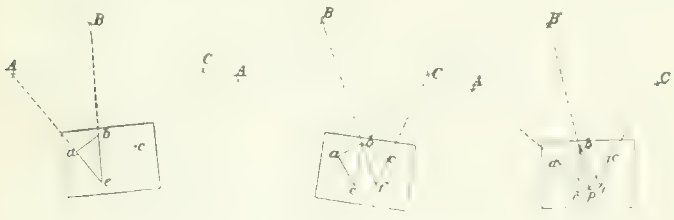

Fig. 3.

was this advantage manifest on trial, but the facility of soon estimating whether a station selected at random was within the limits of plotting, the reason of which is inherent in the fact that the required point lies in the line of two previously determined intersections.

The field routine of this method is as follows—

(The three positions of the board in Fig. 3 correspond to the three principal steps.)

First Step.—(1) Level up the table over P, the station selected, and draw a line perpendicular to a b at a. (This corresponds to erecting the perpendicular a e in Fig. 1.) (2) Place the fiducial edge of the alidade ruler along this perpendicular, and sight through a at A, the corresponding point in the field. Clamp the board in this position and repeat the sight as a check against movement. (3) Fix a pin in the board at b, and, keeping the fiducial edge against this pin, turn the alidade until the point B is seen bisected by the cross-hairs of the telescope, or, in the case of a sighted alidade, coincident with the sighting slits. Draw a line along the fiducial edge to intersect the perpendicular in e. (Thus at e, θ, the angle subtended by A B at P, Fig. 1, is set out graphically, the board being regarded a point in comparison with the area surveyed.) (4) Unclamp the board.

Second Step.—(1) Draw a line perpendicular to b c at c. (This corresponds to erecting the perpendicular c f in Fig. 1.) (2) Place the fiducial edge along this perpendicular, and sight through c at C. Clamp the board in this position, and take a check sight against movement. (3) Turn the fiducial edge about the pin at b until the point B is seen bisected by the cross-hairs of the telescope, and, holding the alidade in this position, draw a line along the fiducial edge to intersect the perpendicular from c in f. (Setting out the angle ϕ graphically at f, Fig. 1.) (4) Unclamp the board.

Third Step.—(1) Place the fiducial edge through the points e and f, and slide a set-square along that edge to p, the foot of the perpendicular from b on e f. (This corresponds to joining e and f, and letting fall the perpendicular from b on that line.) (2) With the fiducial edge through p and b, orient by sighting at B in the direction p b; clamp the board in this position, and check the accuracy of p by sighting through a to A, and through c to C. (Checking by resection.) No "triangle of error" should result—i.e., the rays passing from A, B, and C through a, b, and c respectively should definitely intersect at p.

Notes.—(1) When the station P is situated on the circle through A, B, and C, the problem is indeterminate. This case is evident when the lines b e, b f coincide, but in practice the limit is reached when the angle e b f is very small.

(2) When one or both of the angles subtended at P are greater than 90 deg. (as is the case when P is within the triangle formed by A, B, and C) obtain the intersection e_1 or f_1, or both, as the case may be, by producing backwards one or both of the perpendiculars at a and c (Fig. 1).

(3) When one or both of the intersections e and f cannot be obtained within the limits of the board, the point p may also be indeterminate for the stations selected. The likelihood of this result should be judged (by estimating the position of the line between e and f) before resort is made to the following construction:—

Erect perpendiculars at the middle points of the lines a b and b c—i.e., parallels to a e and c f, to intersect the lines from b to e and f in, say, o and o^1 respectively (Fig. 1). Let fall, as in text, a perpendicular from b on the line joining o and o^1, and, using this as a means of orientation with respect to B, determine by resection the position of p.

Bisection.—Any convenient ratio other than one-half may be chosen, provided that the lines a b, b c are proportionately divided from b.

CANADIAN INLAND WATERWAYS.

Preparation on the part of the Government for the construction of a new canal at Sault Ste. Marie indicates the magnitude of the scheme to improve the navigation of Canada's great waterway of the St. Lawrence and the Great Lakes. It is now evident that besides the new Welland Canal another will be built at the Soo, and the St. Lawrence canals deepened so that all will be equal in facility and size for handling the greatly expanding traffic. The new Welland Canal will have a depth of 31 feet, which can be increased 4 feet without rebuilding the locks, so that this waterway is eventually intended to accommodate vessels of 35-foot draft, or equal to many of the large liners now running between Montreal and Liverpool. The Soo Canal will be constructed of an equal depth, and the improvement of the St. Lawrence canals will give Canada a waterway from the ocean to Fort William that the largest ocean freighters can navigate. Cargoes will not need to be broken as they now are at Port Colborne, Kingston and Montreal. Toronto Harbor must be completed in four years. By this time the new Welland Canal will be ready for traffic, and from the activity of the Government it is certain that along the whole length of this great waterway the improvements on the canal systems and harbors will either be completed or nearing completion.

PARAFFIN BODIES IN COAL TAR CREOSOTE AND THEIR BEARING ON SPECIFICATIONS.*

By S. R. Church and John Morris Weiss.

IN specifications for coal tar creosote there is usually a paragraph stating that the oil shall be a pure product of coal tar, and free from adulteration with any oil or products from any other tar. The purpose of this clause is usually to provide against admixture with petroleum products, such as water gas tar or oil tar derivatives. In the present paper the writers wish to consider one requirement which is sometimes introduced with the object of enforcing this provision.

Coal tar is made up mainly of aromatic compounds, and the presence of bodies belonging to the saturated paraffin series has been regarded by some as direct and unmistakable evidence of contamination of coal tar creosote by distillates from other tars.

Dean and Bateman[1] proposed a sulphonation test for creosote oils, based on the principle that aromatic hydrocarbons dissolve in concentrated sulphuric acid to sulphonic acids, while bodies of the paraffin series remain unattacked. They applied this test to numerous creosote oils, and concluded that any oil yielding a sulphonation residue was contaminated with products of other source than coal tar.

A modification of this test, devised by J. M. Weiss, was proposed in an article by S. R. Church,[2] which did not in any way change the results of the test, but merely made it easier of operation, so far as the detection of traces was concerned. Later, Bateman[3] made further modifications in the test, which made it a still more convenient laboratory operation. This modification was endorsed by Church[4] after trial as more convenient and practical than the earlier proposals.

Chapin[5] proposed the substitution of a dimethyl sulphate test to be used to determine paraffin hydrocarbons in creosote oil, as well as in creosote oil dips. Reeve and Lewis[6] have used this test, and have given a number of results obtained by it.

A brief description of the tests in question may be useful in this connection:—

Sulphonation Test.—"Ten cubic centimeters of the fraction of creosote to be tested are measured into a Babcock milk bottle. To this is added 40 cubic centimeters of 37 times normal sulphuric acid, 10 cubic centimeters at a time. The bottle with its contents is shaken for two minutes after each addition of 10 cubic centimeters of acid. After all the acid has been added, the bottle is kept at a constant temperature of from 98° to 100° Centigrade for 1 hour, during which time it is shaken vigorously every ten minutes. At the end of an hour the bottle is removed, cooled and filled to the top of the graduation with ordinary sulphuric acid, and then whirled for 5 minutes in a Babcock separator. The unsulphonated residue is then read off from the graduations."

Dimethyl Sulphate Test.—"Five cubic centimeters of the fraction is pipetted into a narrow 25 cubic centimeter burette, and shaken with 8 cubic centimeters of dimethyl sulphate after closing the burette with a smooth, close-fitting cork. Separation of the residual oil occurs in a short time in the form of a clear, almost colorless, supernatant liquid layer."

* Presented before Section D of the American Association for the Advancement of Science at the Atlanta Meeting, December, 1913.

We will first briefly discuss the relative merits and demerits of the sulphonation test and the dimethyl sulphate test, and then consider in what manner the results of such a test should be interpreted, particularly as regards creosote oil specifications.

We have made some experiments, using the dimethyl sulphate test, as recommended by Chapin, and the modified sulphonation test with fuming sulphuric acid and the Babcock bottle, as proposed by Bateman. Average samples of coal tar oil and water gas tar oil were distilled, and fractions taken from 240° to 270° Centigrade, and from 270° to 300° Centigrade. These fractions were then subjected to the dimethyl sulphate test and the sulphonation test, with the following results:—

	Sulphonation Test Residue.	Dimethyl Sulphate Test Residue.
Coal tar distillate, 240-270° C....	1.2%	0
Coal tar distillate, 270-300° C....	2.0	0
Water gas tar distillate, 240-270° C.	4.0	0
Water gas tar distillate, 270-300° C.	6.8	0

Further tests on other oils were also made, with the following results:—

	Sulphonation Test Residue.	Dimethyl Sulphate Test Residue.
Water gas tar distillate, 240-270° C.	2.4%	0.0%
Water gas tar distillate, 270-330° C.	1.2	0.0
Mixed tar distillate, 240-270° C...	2.0	0.0
Mixed tar distillate, 270-330° C...	3.0	0.0
Blast furnace tar distillate, 240-270° C.	17.6	23.0
Blast furnace tar distillate, 270-330° C.	23.2	38.0
Oil tar distillate, 240-270° C.....	14.4	22.0
Oil tar distillate, 270-330° C.....	18.8	28.0

It can be seen from these results that the dimethyl sulphate method showed no residue in many oils that gave measurable residues by the sulphonation method, and we feel that the former test is of no value, so far as the detection of small amounts of saturated hydrocarbons in the presence of aromatic hydrocarbons is concerned. Undoubtedly, if there were considerable amounts of petroleum or blast furnace tar distillate present, where there might be a sulphonation residue of from 10 to 20 per cent., the dimethyl sulphate test would detect it, but where there is only a question of comparatively small admixtures of material, itself low in sulphonation residue, this test would not seem to be of any value.

We have experienced great difficulty in obtaining dimethyl sulphate; moreover, we find that it rapidly changes on standing, so that fresh supplies must frequently be had. Another objection to this reagent is the danger attendant upon handling it.

In a great deal of our laboratory work on oils distilled from various kinds of tar, the results have been clouded by uncertainty as to the authenticity of the sample. Some time ago, therefore, we procured samples of tars from typical coke ovens and gas plants under such conditions as to make accidental contamination or admixture practically impossible. These tars were distilled to pitch, and the distillate oils recovered. The oils were subjected to a number of tests, partially along the lines of Dean and Bateman's work (loc cit). It is not our intention to give the details of this work at present, except in so far as they affect the question of the sulphonation test.

Coal tars may be divided into two classes:—

1. Coke oven tars, which may be further subdivided according to the type of oven in which the coal is carbonized.

2. Gas works tars, which may be divided similarly into horizontal, inclined and vertical gas works tars.

In this investigation we had one or more samples from each of the different types of installation, both coke oven and gas works, and have, we believe, examined a sufficient number of samples to draw correct conclusions.

The examination of the oils, which is of interest in this connection, was a Hempel distillation (made in accordance with the Forest Service method for analysis of creosote oil), taking fractions at the following points on the Centigrade thermometer: 210°; 210-225°; 225-235°; 235-245°; 245-255°; 255-265°; 256-275°; 275-285°; 285-295°; 295-305°; 305-320°; 320-330°. These fractions were then subjected to the sulphonation test, using Bateman's modified, as described above. In the appended table are given the results of these tests of the various oils examined, representative tests of each type of installation being selected. Where there were any great variations between oils of the same origin, the tests of the two most widely divergent materials examined are given:—

Sulphonation Residues of Oils from Authentic Samples of Tar.

Oils derived from	210°	210-225°	225-235°	235-245°	245-255°	255-265°	265-275°	275-285°	285-295°	295-305°	305-320°	320-330°
Semet-Solvay coke oven tar	0	0	0	0	0	0	0	0	0	0	0	0
Koppers coke oven tar	0	0	0	0	0	0	0	0	0	0	0	0
United Otto coke oven tar	0	0	0	0	0	0	0	0	0	0	0	0
Horizontal gas retort tar	0.2	0.2	0.4	0.6	0.8	0.8	0.8	0.8	0.8	0.4	0.4	0.4
Inclined gas retort tar	2.0	2.0	2.0	4.0	5.6	6.4	5.2	6.4	6.0	5.6	5.2	4.0
Vertical gas retort tar	5.8	3.6	3.6	4.6	5.6	5.6	6.2	4.8	6.0	4.0	4.4	2.2
Water gas tar, 1	0.4	0.4	0.4	0.4	0.4	0.8	0.8	0.8	0.8	0.8	0.4	0.4
Water gas tar, 2	3.2	5.2	6.0	6.4	7.2	9.2	10.4	10.0	14.2	13.6	13.6	12.4
Oil tar	9.2	22.8	26.4	26.4	26.0	33.2	31.6	35.6	42.4	36.0	32.0	32.0
Blast furnace tar	...	11.6	14.4	16.4	17.2	20.4	21.2	22.0	20.8	20.4	18.0	16.4
Lignite tar	7.0	7.0	9.8	11.6	13.4	14.8	17.0	20.4	20.4	19.6	19.0	12.0

A consideration of the creosote oil specifications in active use indicates a tendency toward the use of the sulphonation test. The requirements of the test vary widely; in one case, the sulphonation residue is limited to 10 per cent. in others, to 1 per cent., while still others specify that in the fraction 300° to 360° C. it shall not exceed 0.25 c.c.

In a Forest Service Circular C. P. Winslow[7] gives the requirement for Class 1 and Class 2 coal tar creosotes, which are the only ones considered by him as pure coal tar creosotes, that there shall be no sulphonation residue. In "mixed coal tar creosotes," he allows, in Class 1, 10 per cent. of the 305-320° C. fraction as a sulphonation residue, and in Class 2, 20 per cent. of the fraction 305-320° C., expressing it in the form that "the volume of the sulphonation residue in cubic centimeters should not be greater than one-tenth or one-fifth, respectively, of the weight of the fraction in grams."

In the opinion of the writers, the requirement of no sulphonation residue is unfair as a basis of classification of pure coal tar creosote; and a very high limit for mixed creosotes, such as 10 to 20 per cent., is useless, as it makes it unnecessary, *per se*, to have any coal tar creosote at all present, in view of the fact that a great majority of the water gas tar distillates have considerably less than this amount of sulphonation residue in any fraction. If a requirement for no sulphonation residue should be enforced, only straight coke oven tars could be used to produce such creosote oils, and this is certainly a commercial impossibility for the most part. If a limit of 1 per cent. is set, the coke oven tar oils and some of the horizontal gas works tar oils would meet the requirement, but some of the latter would require the admixture of coke oven tar oils to bring the percentage below this limit. Also, if a tar distiller should be handling considerable quantities of inclined or vertical gas works tars, oils containing as low as 15 to 20 per cent. derived from these tars might fall outside of the 1 per cent. sulphonation residue limit.

The writers feel that a fairer limit for such specifications would be about 2 per cent., as this would not bar any normal coal tar creosote oils, and would at the same time prevent the admixture of petroleum products (other than those from water gas tar), blast furnace oils, etc. The admixture of water gas distillates will, of necessity, have to be taken care of in some other way than by the sulphonation test, as it is very plain that certain mixtures of coke oven tar oil and water gas tar oil of a low sulphonation residue, would show a lesser sulphonation residue than most oils obtained wholly from gas works coal tars.

We believe, moreover, that we have demonstrated the sulphonation test of itself to be of comparatively little value in detecting the admixture of oils of petroleum origin, particularly those derived from water gas tar, with creosote oil.

In a later paper we intend to publish additional data from our analyses of authentic tars, indicating the value of certain other tests, as means of determining the origin of oils used for creosoting.

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PIPE CONDUITS MADE OF CONCRETE.

An economical method of constructing efficient and durable conduits of concrete for small steam lines is described in a recent issue of "Power," from which the following illustrations and remarks are reproduced:—

The trouble experienced in installing and maintaining steam lines underground is well known, especially where cinders have been used for grading. To lay a pipe line in cinders means a continuous digging up and renewing of pipes, for the life of wrought-iron or steel pipe in cinders is short and cinders alone make a poor insulator.

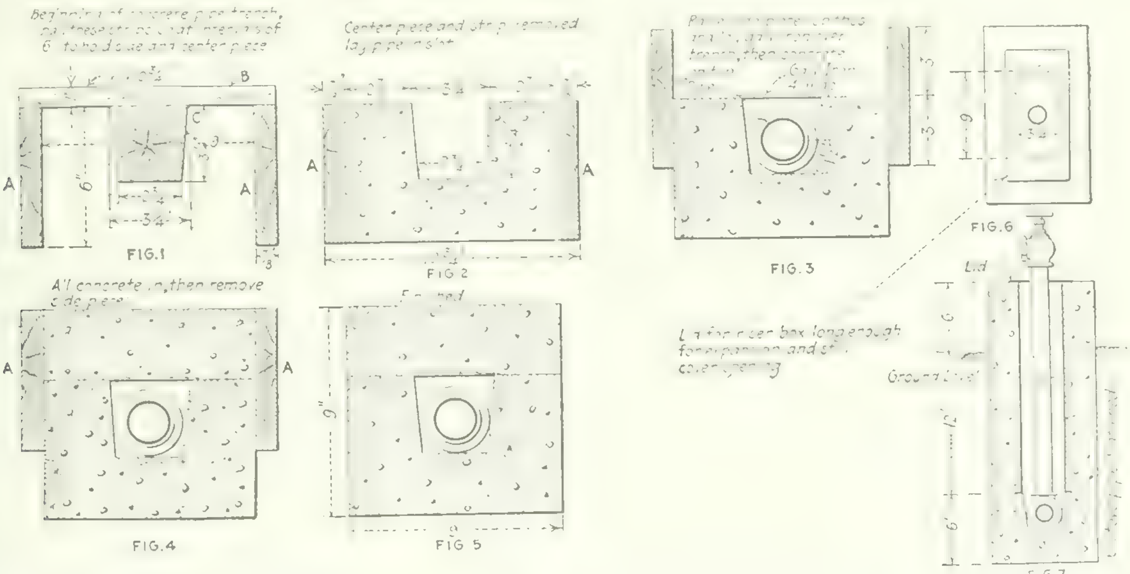
Some kind of covering must be employed to save the pipe and to prevent condensation. After using several kinds of material, including tin-lined wood casing, ordinary tile, split tile, and oak, pine, cypress and other kinds of wood coverings, each has been found to have its faults. Concrete conduits have been used for air and oil lines, there being little expansion or contraction, but providing for a steam line is a different proposition. With the knowledge gained in laying approximately 17,000 ft. of air lines in concrete, and knowing that it was immune from disintegrating action of the elements and of the cinders, a similar conduit for steam pipes was employed. It is very simple and less expensive than others, and to those who would keep down the cost of maintenance and raise the standard of service, our manner of providing conduits for small sizes of underground steam pipes may be of interest.

A method of providing for a 2-in. steam line would be to first dig a trench the required size and depth, and set in it two ⅞ x 6-in. fence boards *A*, Fig. 1, placed on edge, 9 in. apart. Next, nail a piece *C*, used as a core for forming the slot in the centre, to the strips *B*, 1 x 1 x 10¾ in. spaced 6 ft. apart, and tack them to the side boards. The ditch is then filled with concrete in sections, each about 12 ft. long, made of 10 parts of small stone or gravel, five parts sand and two parts cement. Mix the concrete to a slush and fill the form level with the top. Do not trowel the top, but use a broom to roughen the top surface, as the top will adhere better than if slicked with a trowel.

When the concrete is set, and it will generally harden enough in 12 hr., remove the strips *B* and lift out the centre core, leaving the concrete as shown in Fig. 2.

Now lay the pipe, as shown in Fig. 3, and cover the slot with a strip of thin galvanized or stove-pipe iron about 4 in. wide. Raise the side boards up 3 in., tamp dirt around the outside to hold the boards in place and fill with concrete to the top of the side boards, as in Fig. 4. When the concrete has set dry, remove the side boards, leaving the finished conduit of section like Fig. 5. If the ground is likely to hold water after a rain, it is well as an extra precaution to coat the sides and top of the conduit with hot coal tar, or with a heavy paint.

Care should be used where the risers come above the ground. For such places use a piece of 7-in. stove-pipe of the right length, split and flanged over at the lower end, and flatten the sides so as to leave space for the steam line to expand. After placing the stove pipe over the riser, set a box 9 x 15 in. around the stove pipe, both extended about 6 in. above the ground line, and fill with concrete, as in plan, Fig. 6, and vertical section, Fig. 7. When the concrete has set, remove the outside form, pack the dirt firmly around the riser box and provide a sliding lid of sheet iron, as shown, to exclude dirt and hinder the circulation of air.



Figs. 1, 2, 3, 4 and 5.—Cross-Sections of Conduit. Fig. 6.—Lid for Riser Box. Fig. 7.—Vertical Section of a Riser Box. Concrete Conduit for 2-in. Steam Line.

If a leak appears, remove a section of the top with a wedge, draw out the pipe, repair the leak and replace the top with new concrete. A length of 25 ft. of pipe can be drawn out and replaced with no trouble. This cannot be done with wood, log, tile, wooden box, or most other kinds of conduit on account of the inside supports. Many hundred feet of this kind of conduit have been installed and no trace of cracks has been found at any of the places that were uncovered to examine the concrete.

Giving evidence before the Dominion's Commission on March 14, Mr. Nicholson, harbor engineer, stated that in the [illegible] able to accommodate vessels 750 feet long and drawing 38 feet of water; and also that further development work had [illegible]

In 1913, [illegible] found employment in the mines, quarries, clay-pits and ore-mills in the Province of Quebec. The total wages paid amounted to \$5,179,395. A certain proportion of these men were employed for part of the year only, but the majority worked 300 days. [illegible] asbestos mines; four in quarries, and one in a copper mine.

THE WET FILTRATION OF COOLING AIR FOR ELECTRICAL MACHINERY.

THE application of air, cleaned by what is now generally known as wet filtration, to the cooling of electrical machinery is a comparatively recent innovation, and the installations of this type are as yet few in number. Owing to the rapidly increasing number of turbine-driven generators requiring large and constant volumes of ventilating air, engineers are much interested in the method, and are discussing its possibilities. While on the one hand some are favorably disposed towards the new practice, the majority, frankly doubtful, prefer to await the verdict of time in those cases where it is in use before coming to a final decision. As the time is opportune, we reproduce the following remarks on the subject contained in an article by Mr. D. A. Hackett in the Electrical Review, dealing with a few of the technical aspects, with the view of stimulating the discussion of the practice.

The process of wet filtration may be briefly described as the bringing of the air which is to be cleaned into intimate contact with water in the form of a very finely divided spray. The air may thus be said to be actually washed, for as the particles form nuclei for the formation of drops, they are removed from the air current passing through the apparatus, both by their rate of fall being rendered greater and by the interposition, in the path of the spray-laden air, of specially shaped baffles from which the air issues clean and without trace of suspended moisture. In addition to the removal of dust particles, the no less objectionable acids, or acid-forming gases, are removed, being absorbed by the water.

The first question that arises is whether it is possible for the water particles to be carried over from the filter by the moving air. It is simply a matter of installing apparatus capable of dealing with the quantity of air required, and there is little doubt that manufacturers of this class of plant would be able to fulfil guarantees of the absolute absence of every trace of suspended moisture in the discharge from the filter.

The air leaving the apparatus is humid, and the greatest amount of discussion in connection with this subject has been devoted to the possibilities attaching to this condition. The insulation resistance of material is reduced by the presence of moisture in it, and considering only the humidity of the filtered air, it might be unsafe, to say the least, to pass it in its practically saturated condition through a machine. This view may be considered from several aspects. It must be remembered that the climate of this country is such, that electrical machines are frequently subjected (more often of course in winter) to atmospheric conditions approximating to 100 per cent. humidity for long periods. This is the case particularly where the machines are of the type requiring forced ventilation, and it is ordinary practice, where the environment is suitable, that is, where the atmosphere remains clean, to pass the air through machines unfiltered, without damage resulting to the insulation. In foggy weather the air is supersaturated and contains particles of moisture, but there is no record of machines having broken down due to the reduction of the insulation resistance at such times, nor is any provision ever made to reduce the quantity of moisture in the event of a fog or unusually humid atmospheric conditions. Finally, machines are insulated for use under ordinary conditions of surrounding air; in practice manufacturers' tests are assumed to be made without any special precautions with regard to humidity, and in very many cases it is even specified that the apparatus under consideration should remain in the shops for some days previous to testing subjected to ordinary atmospheric conditions. It would appear then, that the factor of safety of insulation as applied to electrical machines in general would cover such of these as are ventilated by wet-filtered air.

It might be of interest to examine the effect of the passage of the air to and through the machine, on the air itself. Let it be assumed that the filtered air is saturated, that is, that its humidity is 100 per cent. (actually it does not always reach this, the average condition being more nearly represented by 95 per cent.). The air leaving the filter passes to the machine but before coming into contact with the windings, it has to encounter resistance in the form of ducts and bends, and has also to be forced through the machine by some form of fan. In this process energy is expended, the air temperature is raised, and the humidity thereby reduced. It may seem that this effect is slight, but in the first place it requires a comparatively small amount of energy to raise the temperature of a cubic foot of air through one degree (0.575 watts per cubic foot per minute), and for a given moisture content the humidity of a given weight of air decreases rapidly as its temperature rises.

If air at 19.5 degrees C. and 100 per cent. humidity at normal atmospheric pressure, have its temperature raised one and a half degrees, the humidity drops to 90 per cent. If an actual case be taken, and assuming 65 per cent. as an average figure for the efficiency of the external fan supplying air to the machine, calculation shows that the losses in the fan and ducts produce an increase in temperature of about three degrees before the air comes in contact with the windings. The resulting humidity in this case with 100 per cent. leaving the filter is 79 per cent., which is below the average for winter atmospheric conditions in this climate.

It has also been pointed out that the air around a central station, by reason of the water vapor liberated in various operations, has, as a rule, a large amount of suspended moisture present against which no special precautions are taken.

The effect of the heating of the machine itself must be considered. An examination of the heating curve shows a sharp and immediate rise in temperature after putting on load. This should act in the direction of preventing an undue absorption of moisture by the windings, should the humidity be high. It is also worthy of consideration to note that in a generating station, due to the radiation from steam pipes, engines and generators, the air temperature is higher than the external air, and, as a result, the windings of a machine, when put on load, are already several degrees higher than the cooling air, and therefore initially more likely to resist the condensation of moisture in them. This fact, taken in conjunction with the rapid rise in temperature referred to previously, and the increase in temperature due to work done in moving the air, tends towards the reduction of the percentage of humidity, and therefore to the original condition of the air as regards moisture previous to filtration.

It is claimed that the air is cooled as well as cleaned by the process of wet filtration, and as this tends in the direction of a lower maximum temperature, it is desirable to form some idea as to the amount of the reduction in air temperature and the effect of the increased moisture content on the cooling qualities of the air, that is, practically speaking, on its specific heat. If air be taken at atmospheric conditions of temperature, pressure and hu-

midity, and caused to take up water vapor in such an apparatus as the filter under discussion, the air will be cooled owing to the heat absorbed in the evaporation of the water. It is correct to assume that the quantity of heat lost by the air is equal to that absorbed by the water during evaporation. From this consideration the reduction in temperature due to air taking up various quantities of moisture can be calculated, and from hygrometric charts it is a simple matter to obtain the amount of vapor present at the assumed condition (for air leaving the filter) of 100 per cent. humidity at any temperature. The temperature to which air at any other temperature and humidity falls when saturated in this manner, can be obtained with reasonable accuracy. The air temperature will not be reduced quite to the wet-bulb temperature corresponding to the atmospheric conditions, but to a temperature slightly higher, due to the increase of the moisture content consequent on the passage through the filter. A concrete example will make evident the extent of the cooling effect.

If air at 13.9 degrees C. and 81 per cent. humidity, corresponding to average summer conditions, be treated in a wet filter so that it emerges at 100 per cent. humidity, the resulting air temperature is 12 degrees C. The wet-bulb temperature corresponding to the original conditions is 11.75 degrees C. The cooling effect is due mainly to the latent heat absorbed by the water in evaporating, and it does not seem feasible except possibly in special cases still further to reduce the temperature materially by the addition of refrigerating plant, cooling the water supplying the sprays in the filter. It is doubtful if much advantage can be gained in this way unless some highly efficient, compact refrigerator capable of operating without supervision, can be found.

With regard to alteration in cooling qualities, an investigation of the change in specific heat and density, for the average conditions given, shows a 0.2 per cent. increase in specific heat, and an increase in density of, approximately, the same amount, so that there is a slight advantage in these respects also.

Summing up, it would seem that there is a fairly good case for the installation of wet air-filtration apparatus from the purely technical aspect. It undoubtedly produces clean air, the advantages of which it is not necessary to dwell upon, and whilst the reduction in temperature may not, generally, be great, the air is certainly cooler after filtration. With regard to the danger of breakdown, it would be of interest if some experiments were carried out under actual conditions to discover if any material alteration in insulation resistance does occur, and in this connection experience might be gained at first on low-voltage machines, where the risk of breakdown is less. It is outside the scope of this article to discuss the costs of such installations, the different types, or comparative figures for upkeep, but it might be urged that the publication of such particulars would be of the greatest interest to electrical engineers in general at the present time.

The business of the Tungstolier Company of Canada has been taken over by the Canadian General Electric Co., Limited.

It has been stated at Philadelphia that part of the pig iron which R. D. Wood and Company will cast into pipe in their 40,000-ton Italian aqueduct contract, will be brought there from Canada. This particular iron will come from Sydney, Nova Scotia. About 15,000 tons is understood to have been contracted for to be delivered at docks at Philadelphia at about $13.50 per ton.

CONSTRUCTION OF A JETTY OF SPECIAL DESIGN.

By V. J. Elmont, B.Sc., A.M.Can.Soc.C.E.

On the west coast of the Danish peninsula, Jutland, there has been completed a jetty, built of concrete blocks. It is worthy of record on account of the magnitude of the blocks, which are up to 102 tons in weight, its special design, and the difficulties which had to be met during construction owing to the heavy seas on that coast.

The jetty runs 1,000 ft. into the sea and has a width at the top of 20½ ft.; the maximum depth of water is

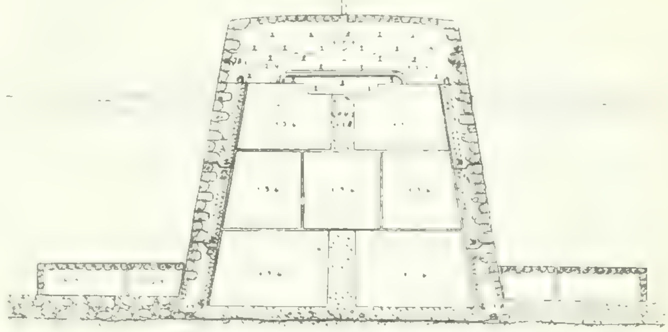


Fig. 1.—Cross-section of Jetty.

20 ft. The masonry of the jetty does not begin directly at the shore, but is connected with it by a bridge. The prevailing current conditions made it necessary to provide a free space between the jetty and the shore in order to prevent deposition along the jetty of sand and gravel carried by the coastwise current.

The cross-section in Fig. 1 shows the method followed in the design. The outside walls are composed of three 16-ft. long granite-faced concrete shells on top of each other, the operation of placing them being effected by means of a Titan crane of 110-ton capacity. The bottom

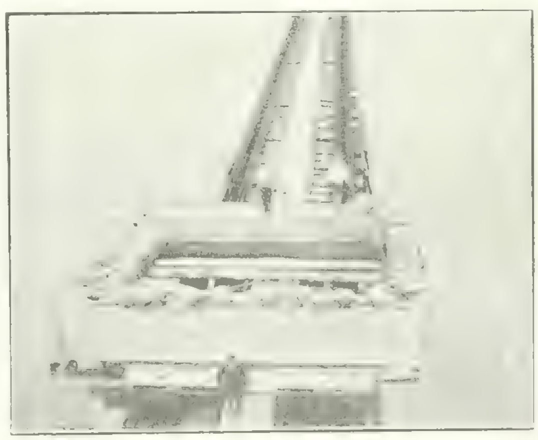


Fig. 2.—Showing a Section on Way to Site.

shell (one of them is seen under transportation in Fig. 2) was placed on the uneven ground, when the loose material covering it had been removed with a grab bucket, attached to the crane (Fig. 3). The bottom shell being in position, a sheet of cloth, connected to the sides of the shell, as indicated in Fig. 2, was spread over the base (shown also in the cross-section). On this was placed a layer of gravel, grouted with cement after being levelled

off. In Fig. 2 will also be noted a thick strand of oakum used to ensure tightness between each pair of shells, and the concrete and cement bags on which the shell was set, thus making a close joint between the base and the shell. The box formed by each set of three shells is filled with concrete blocks and the space left between these with a rich mixture of concrete.

It was originally intended to build the superstructure (granite and concrete masonry) *in situ*, but it was afterwards deemed preferable to adopt block work for a part of it. The superstructure for each section, formed by three shells, was completed by two concrete and granite facing blocks of an average width of 5 ft.; the space between them was filled with 1:2:4 concrete, reinforced with rails running lengthwise in the jetty.

Fig. 3.—110-ton Crane Used in Placing Sections and Blocks.

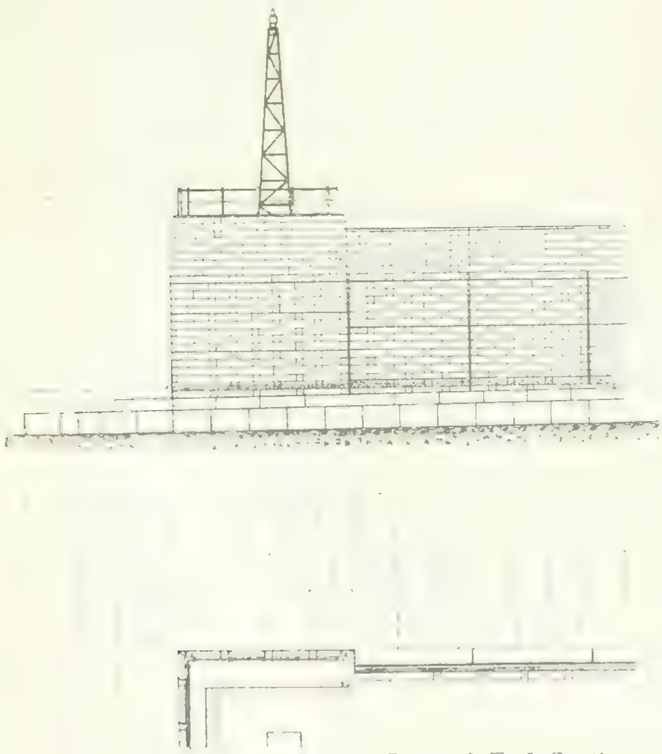


Fig. 4.—Elevation and Half Plan of End Section.

These blocks have the same dimension in the length of the jetty as the shells on which they rest. A continuous expansion joint is thereby formed from the base to the top of the jetty, provision being made for a joint in the concrete forming the centre part of the superstructure.

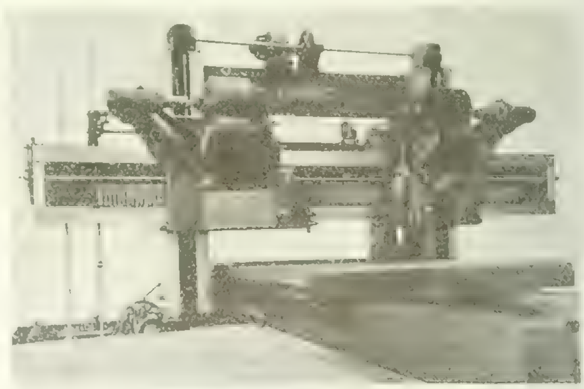
The footing of the jetty is secured against scour by means of two granite-faced concrete blocks on each side, having a total width of 13 ft. At the head of the jetty these blocks are 21 ft. wide, made up of three rows, that nearest to the jetty weighing from 15 to 20 tons, the others 8 and 9 tons respectively.

The head of the jetty (shown in plan and elevation in Fig. 4) was built up of four shells, differing somewhat from those already mentioned. They have vertical sides and are 24 ft. long and 28 ft. wide. Their weight varies from 84 to 102 tons. The total weight of the head section, when filled with concrete blocks, is 1,020 tons, while the one adjacent weighs 638 tons. By the aid of the superstructure these two sections are combined to form one mass, having a weight of 2,035 tons.

SPECIAL PLANER OF INTERESTING DESIGN.

THE unusual type of planer shown in the illustration was built by the Betts Machine Company, Wilmington, Del., for the Commonwealth Steel Company, Granite City, Ill., after the latter company's special design. It is designed especially to machine the ends of castings running up to 30 feet in length, a proceeding that is impossible with the ordinary type of planer. The cutting tools are therefore arranged so as to move at right angles to the platen, which permits machining the ends of castings of any length as well as other surfaces which cannot be reached with the ordinary planer.

The machine consists essentially of a 10 x 7 x 18 ft. planer of standard construction. The cross rail is, however, special and carries two cutting heads, each of which



Planer for Machining Large Castings.

is driven by a 30-h.p. Westinghouse electric reversing planer-motor.

The two motors are connected together electrically so that if one reaches the end of a stroke before the other, it automatically stops and waits for the other to finish its stroke, when they both reverse together. To obviate the danger of the heads running together, a push-rod is mounted on one which opens the circuit and stops the motors if pressed.

The heads are designed for a cutting speed of 30 ft. per minute and a return speed of 75 ft. per minute, and are guaranteed to take two ½ x ⅛-inch cuts simultaneously in cast steel.

The platen is provided with a power rapid traverse of 20 ft. per minute as well as a power feed. It is driven by a 7½-h.p. motor, while the cross rail is raised and lowered by a similar motor.

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CONTENTS OF THIS ISSUE.

LOCAL GOVERNMENT BOARD IN SASKATCHEWAN.

The Third Legislature of Saskatchewan, recently concluded, passed an act to provide for the creation of a Local Government Board, to consist of three members and to exercise broad control over the financial affairs of the municipalities of the province.

Associated with the commissioners for advisory purposes will be two members, appointed annually, one by the organization representing urban municipalities, and the other representing the organization of rural municipalities. The commissioners are not allowed to hold any interest in the securities of Saskatchewan local authorities, or to be members of any company dealing in their securities, nor may they be interested in any work done or contracts let by these authorities. They are also disfranchised both as to municipal and provincial elections.

The term "local authorities" is defined under the Act to mean the council of a city, town, village or rural municipality, the board of trustees of a school district, and the directors of rural telephone companies.

The duties of the board may be briefly summarized as follows: It will have power to inquire into the merits of an application from any of these authorities for permission to raise money by way of debentures or upon security of stock; it may grant or refuse such permission; it may manage sinking funds entrusted to its care; it may supervise the expenditure of money by local authorities; it may demand a detailed statement of the financial standing of local authorities.

All local authorities, excepting cities and towns, desiring to raise money by way of loan, must first make application to the board. Cities and towns must do so prior to the first reading of the money by-law. None of the terms of the existing law as affecting villages and rural municipalities are altered in any way, except that the powers formerly vested in the Minister of Municipal Affairs will in future be vested in the Local Government Board. The same conditions will apply to school districts and rural telephone companies.

The board is given power to investigate the advisability or otherwise of authorizing a loan, and when money is to be borrowed for waterworks or sewerage systems the approval of the Commissioner of Public Health must first be procured, as is provided in the Public Health Act.

The board will have the right to enter upon and inspect any works, require the attendance of any persons whom it sees fit to summon and the production of all desired documents or plans, and in forcing the attendance of witnesses will have the same powers as the Supreme Court.

NO TIME TO TENDER.

Hardly a week elapses but that there is announced some important call for tenders which allows bidders only a week or two for the preparation of their tenders.

"No time to tender" has become a very familiar phrase among Canadian engineering, contracting and manufacturing concerns. Important firms are frequently barred from tendering, simply because of the time element. There are rare occasions when a town or city really requires material or machinery in a hurry. But nine times out of ten, the time allowed bidders could probably be increased by a fortnight, or even a month, without any detriment to the municipality—especially if a little foresight were used and tenders called for promptly

as soon as decision to have the work done had been reached.

Too frequently a council decides one meeting to call for tenders and instructs the city clerk to have tenders in hand by the next council meeting. We have in mind one Canadian municipality that allowed only a couple of weeks for tenders for an engine, and then calmly waited for eighteen months for its delivery; and another municipality that allowed less than two months for the preparation of plans and bids on a job amounting to over a million dollars, and then took over ten weeks to decide which of two bidders should be awarded the contract.

This is a matter of equal importance to buyers and sellers, as bidders often submit figures high enough to protect themselves against all risks, when they are not allowed sufficient time to investigate carefully and to figure accurately and closely.

REPORT ON CITY ARCHITECT'S DEPARTMENT, TORONTO.

Last week Judge Denton's report on the City Architect's Department was made public. It is the result of a lengthy investigation, and careful probing into the affairs of the department has brought out strong vindication of the popular belief that much inefficiency and lack of discipline pervaded the system under which it operated.

During the three months of the inquiry 179 witnesses were examined, 2,614 typewritten pages of evidence taken and 170 exhibits filed and considered.

The report recommends a complete reorganization of the department into a separate branch of civic government to be known as the "Department of Buildings." Its jurisdiction and powers are fully enumerated and show considerable increase over the present system. The head of the department, according to the recommendation in the report, should be called the Superintendent of Buildings.

"He should be the best man available. He should not only have the necessary practical and technical knowledge of the work of the department, but should possess the necessary administrative ability to reorganize and systematize the department and to introduce such reforms as will put an end for all time to come of the conditions at present existing."

The official disclosure of many inconsistencies renders it almost inconceivable that the present condition of affairs will be permitted to continue. Obviously, the department is one of the most important in the administration of civic affairs. There is every need for a superintendent possessing (1) technical ability that may be relied upon for accuracy and dispatch in engineering and architural details; (2) executive ability to reorganize and resystemize the department in order to make it efficient, reliable and up-to-date; (3) practical knowledge of the factors representative of the owner, the engineer, the architect, the contractor, the city and the building by-law; (4) disciplinary powers such that the practices which the present department has tolerated will immediately, without modification, cease.

Further, the responsibilities of this office are such as to require a man who will rigidly adhere to the belief that his is a department that cannot permit an invasion of foreign forces in the carrying out of its duties for the protection of life and property.

LETTERS TO THE EDITOR.

Artesian Water in Manitoba.

Sir,—For many years, in fact almost ever since Winnipeg has been a city, it has depended for its water supply on wells sunk through the impervious layer of boulder clay which underlies the city into a bed of porous limestone, from which water rises in great abundance. From these wells the city has been able to obtain a plentiful supply of water which, while containing a slight amount of mineral matter, is absolutely free from any hurtful bacteria, or from organic germs of any kind.

Probably no city on the continent has such a secure supply of sterile water as Winnipeg, but the city council has evidently decided that the supply is not sufficient and cannot be sufficiently increased to keep pace with the rapid growth of the population, and therefore it is said to be making arrangements to bring water from Lake of the Woods in an open aqueduct, and to take all the chances of the introduction of impurities which such a method of obtaining water necessarily entails.

Before stepping down from a safe and sterile water supply to one which may not always be safe and pure, it would be worth while to make every possible endeavor to increase the flow of pure water from the present wells.

The porous limestone into which these wells are sunk, and from which the water rises, extends to the north and west beneath a layer of boulder clay, and rises to the surface in a number of places in the country between lakes Winnipeg and Manitoba at elevations varying from about fifty to one hundred and fifty feet above the level of the prairie at Winnipeg. The rain falls on these bare rocky areas, as well as on the adjoining clay-covered country, but instead of flowing away in rills and streams, as it does on the clay-covered country, it at once sinks into the porous limestone and flows through this limestone southward and eastward until it finally reaches the surface either in the large springs north of Winnipeg or through the wells at the city of Winnipeg itself. The quantity that flows from these springs and wells is therefore largely limited to the amount of the rain-fall on those portions of the surface where the porous limestone is uncovered. Where it is covered, as it is in many places, most of the water derived from the rain either stands in small lakes and evaporates from the surface, or drains off towards Lake Winnipeg or Lake Manitoba by the many little streams which unwater the country.

The underlying porous limestone through which the water percolates on its way from the exposed areas northwest of Winnipeg to the wells in Winnipeg is a magnificent natural filter which is protected from contaminating influences throughout the populated parts of Manitoba by a thick covering of impervious boulder clay. No other city on the continent is provided by nature with such a filter, and no city could afford to duplicate it. When nature has provided such a magnificently covered filter as this great bed of porous limestone to clarify and purify the water used by its people, those people cannot afford, with due regard to their own health and welfare, to disregard it.

It may be that the supply of water, obtained from the wells sunk into this natural filter basin, is insufficient for a city of the size to which Winnipeg will certainly grow, but it would be well to determine, if the fact has not yet been determined, whether such insufficient supply is the fault of the inefficiency of the natural filter, or whether, as is much more likely to be the case, it may

be caused by an inadequate supply of water to the bed of porous limestone which forms the filter.

If the supply of water available from the wells is inadequate could it not be increased? Could not the lakes and streams which now drain the water from the country to the northwest be diverted into this great natural filter, or even would it not be possible to divert some of the water of Lake Manitoba itself into it?

These questions are worth deciding before the present methods of obtaining pure water from artesian wells is abandoned.

J. B. TYRRELL,
Consulting Geological Engineer.

Toronto, March 31st, 1914.

* * * *

Jointing of Water and Gas Mains.

Sir,—I notice a letter in your issue of the 26th inst., by "Hydraulic Engineer," on "Jointing of Water and Gas Mains."

In regard to his remarks on steel pipe my own experience may be of interest.

I have laid for the Montreal Water and Power Company something over 8 miles of steel main in 60-in., 48-in., 36-in. and 30-in. diameter, and from 7/16 in. to 5/16 in. thickness for working pressures ranging from 200 to 65 lbs. per square inch.

The first mile of 36-in. was laid with a single rivetted butt strap joint. This was found to be a nuisance and expensive to lay as the joint made at the mill (the strap being rivetted to each 30-ft. length of pipe) had to be completely gone over in the field to render tight.

The remaining 6 miles of this line was obtained in tapered pipe with a total taper in 30 ft. equal, approximately, to twice the thickness of the plate. A single row of holes was shop drilled at the end of each length and a single rivetted lap joint, made entirely in the field, thus obtained. This has proved an absolutely satisfactory joint and no trouble has been experienced even with pressures up to 250 lbs.

The high pressure of 250 lbs. has been recorded due to "surging" after a sudden and accidental stoppage of the pumps.

At one point in the main a crossing of the Lachine Canal occurs. This was made in flanged steel pipe, the flanges being steel angles. Experience has shown this to be a weak and unsatisfactory joint, difficult to get tight.

I have not had experience with the lead yarn spigot or faucet joint in steel pipe, but would doubt its durability at high pressures and in large sizes.

F. H. PITCHER,
General Manager and Chief Engineer,
Montreal Water and Power Company.

Montreal, March 31st, 1914.

* * * *

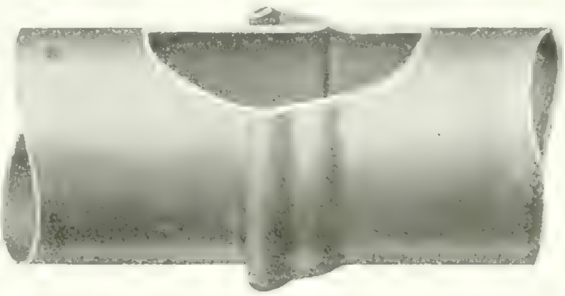
"Jointing of Water and Gas Mains."

Sir,—It is unfortunate that your correspondent "Hydraulic Engineer" did not take a little trouble to become acquainted with the actual facts of the case before making such statements as appeared in his letter in your March 26th issue. Certain of these statements are so misleading that it may interest you to have the exact position placed before you.

Your correspondent states that the process of oxy-acetylene welding is so expensive and difficult to perform, that it can be discarded as not practicable. To the contrary, the new process of welding joints is an acknowledged success, and it may interest your readers to know that orders and repeat orders have been received from about thirty gas and water companies in Great Britain, where, if anywhere, the engineer is most conservative in his ideas. To give one special instance: The City of Birmingham has installed about three miles of 9-inch pipe with this patent joint for gas work, and the probabilities are that many repeat orders will be secured from the same source.

The article in your recent issue on this new process of welding joints gave an account of the effect of expansion, and perhaps your correspondent will be good enough to read that over, so as to improve his ideas on the subject.

Another point to which exception can be taken in your correspondent's remarks is the type of sockets which he advocates for pipe lines. The consensus of opinion of engineers is strongly in favor of the following type:



The reinforced bell end removes any danger of splitting of the pipes during the caulking operation, and the turned-up spigot makes it impossible to draw the pipes apart after they are joined with lead and yarn. There is, also, a very deep groove in the socket for lead, which is a feature wanting in the special type of sockets shown in the sketches in your article of last week. The extensive mileages of pipes with this type of socket now in use can verify its popularity with engineers.

It is hoped that the above remarks will now make matters quite clear to your correspondent as they can be proved by actual fact.

A. HUTCHISON.

Montreal, March 30, 1914.

NEW SURVEYING ACT FOR SASKATCHEWAN.

The old Land Surveyors Act has given place in Saskatchewan to an act passed at the recent meeting of the Legislature of that province. The new legislation differs from the old principally in that the examination of all candidates desirous of obtaining a commission as an S.L.S. is now placed entirely in the hands of the Saskatchewan Land Surveyors' Association. This association is now placed on the same basis, and will receive the same recognition as other professional associations. It is now necessary for Saskatchewan land surveyors desiring to practise in the province to conform to the requirements of the association respecting registration.

The recently-issued report [illegible] Vancouver gives the following [illegible] the city at the close of the year:—Permanent street pavements, 51.453 miles; permanent lane pavements, 3.213 miles; streets, rocked, 146.556 miles; lanes, rocked, 25.050 miles; cement concrete sidewalks, 202.184 miles; sewers, 170.01 miles; water mains, 298.84 miles.

HYDRO-ELECTRIC POWER DEVELOPMENT AT WASDELL'S FALLS.

THE sixth annual report of the Hydro-Electric Power Commission of Ontario contains a section devoted to water-power investigations that are being carried out by the engineers of the Commission on a number of rivers throughout the province. Among them, the one farthest advanced at the present time is

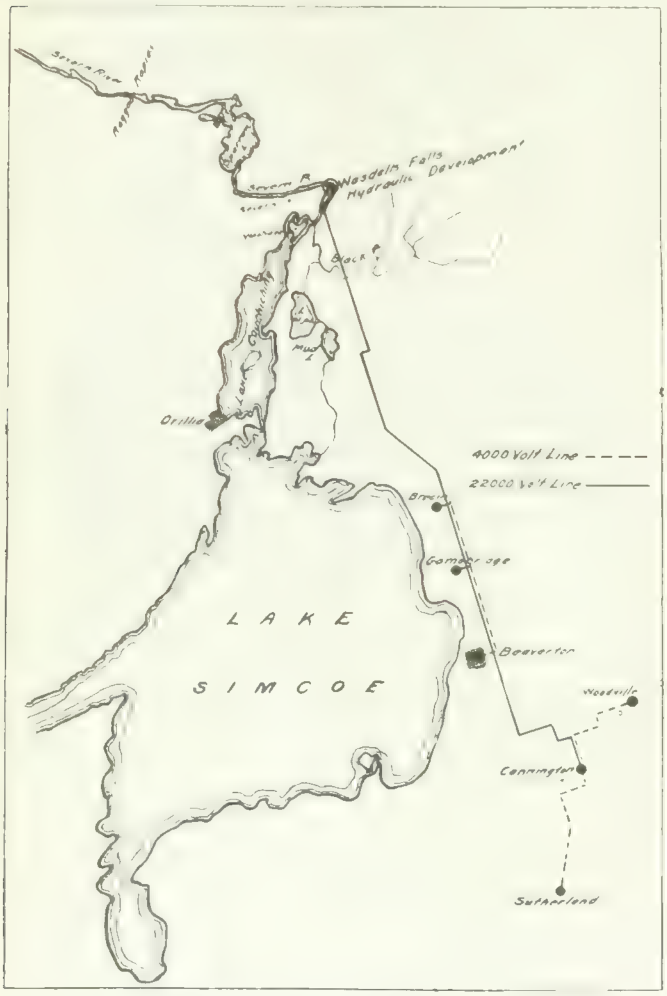


Fig. 1—Wasdell's Falls Development, showing Location and Projected Transmission Lines.

the development at Wasdell's Falls on the Severn River. There power studies are all carried out under the direction of Mr. F. A. Gaby, Chief Engineer of the Commission; by Mr. H. G. Acres, hydraulic engineer, and Mr. T. H. Hogg, assistant hydraulic engineer of the Commission. The information contained in their reports on the Wasdell's Falls project includes the following:—

The drainage area of the Severn River above the power site at Wasdell's Falls is about 2,080 sq. mi. About 700 sq. mi. of this is included in the watershed of the Black River, which joins the Severn about midway between Wasdell's Falls and the outlet of Lake Simcoe at Washago, as shown in Fig. 1. The maximum flow at Wasdell's Falls, as so far ascertained from gauge records and discharge measurements, is 9,000 sec-ft., or 4.32 sec.-ft. per sq. mi. of watershed. Under conditions that will obtain in the future, it is probable that the maximum discharge will never exceed 5 sec.-ft. per sq. mi., this low figure being due mainly to the potent regulating influence of Lake Simcoe, and to a small extent to the smaller lakes in the upper watershed.

The extreme minimum flow, during the period that the river has been under observation by the Commission, was 260 sec.-ft., or 125 sec.-ft. per sq. mi. The average flow for the period from October 1, 1912, to November 1, 1913, was 2,850 sec.-ft., or 1.37 sec.-ft. per sq. mi. This was one of the driest periods on record, so that the above is a fair indication of the minimum value of mean annual flow. On this basis the ratio of maximum to average flow is approximately as 3 to 1.

The area of Lake Simcoe is about 297 sq. mi., and when the Severn section of the Trent Canal is constructed the lake will be completely controlled by regulating dams at Washago. An annual storage draft of 18 in. may then reasonably be considered available, in which event the volume of available storage will be 12,420 million cu. ft., or 284,500 ac. ft.

The plant at Wasdell's Falls is designed for a peak capacity of 1,200 h.p. The Trent Canal works are designed to hold the tail-water level at El. 698, and with the proposed head-water level of El. 712.5, about 950 sec.-ft. of flow will be required to carry the peak load. On a 75% power factor basis the average flow will, therefore, require to be 700 sec.-ft.

The available volume of storage will provide the required average flow for 207 days in each year. Leaving an ample margin for unavoidable waste and inefficiency of operation, it is, therefore, evident that a sufficient supply of water may be anticipated at all times.

The power site at Wasdell's Falls is the only source of power from which the municipalities of Woodville, Sunderland, Cannington, Beaverton, and Brechin, may be economically served. These municipalities, in November, 1912, passed by-laws and subsequently contracted with the Commission for the supply of 625 h.p. Detailed investigations were immediately instituted, and estimates covering the cost of delivered power were submitted to the municipalities and found acceptable. The Commission, acting under authority of the Power Act, obtained an Order-in-Council covering the purchase of the site and the development of power at Wasdell's Falls, and early in 1913, work was begun upon plans and

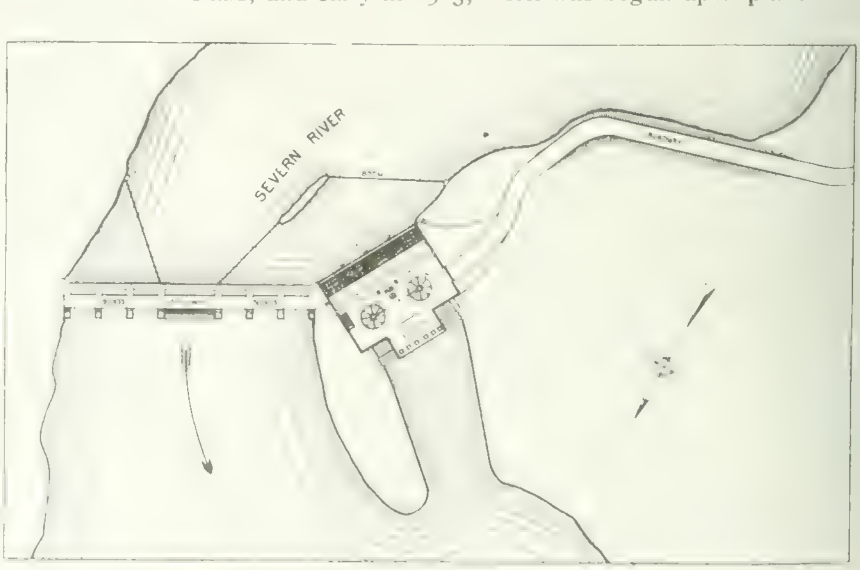


Fig. 2—General Arrangement of Wasdell's Falls Power Plant.

specifications for the hydraulic portion of the plant. Fig. 2 shows the general layout of the development, and Fig. 3 is a cross-section illustrating the power-house arrangement.

Tenders for the construction of the dam and power-house and for the hydraulic equipment were called for in

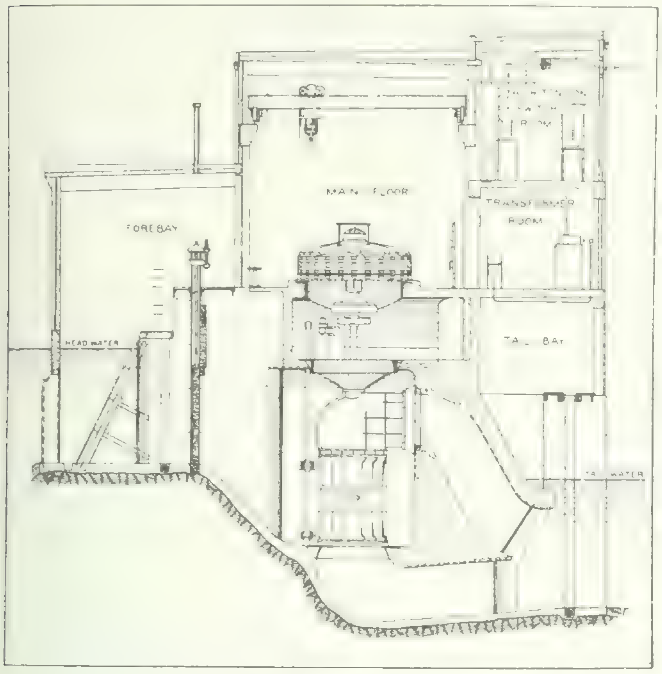


Fig. 3.—Cross-section of Power-house at Wasdell's Falls.

June, 1913. The various contracts awarded were dam and power-house, Galbraith & Cate, Montreal; turbines, Boving Company of Canada, Limited, Toronto; stop-log winch and head-gate lifting mechanism, Wm. Kennedy & Sons, Owen Sound; crane, W. D. Beath & Son, Limited, Toronto.

As regards the dam and power-house contract, the greater portion of the month of July was taken up by

Fig. 4.—Erection of Power Plant, Piers Completed.

the contractor in the purchase of plant and the installation of same at the site of work, and it was not until the middle of August that construction work was well under way. Since that time, however, good progress has been made, and there is every reason to anticipate that under the worst conditions likely to obtain the work will be beyond the reach of the high water of 1914, and with reasonable working conditions the entire works will be completed in May, 1914. Fig. 4 is a progress view of the main dam, showing the piers completed.

The contracts entered into with the above municipalities do not by any means represent the extent of the market which the Wasdell's Falls development will serve. It is confidently expected that a large rural load will be developed in the agricultural townships of Mara, Thorah and Brock, and that the demands of these townships will practically double the present contracted load.

Apart from the low head, the topographical conditions at Wasdell's Falls are favorable for development purposes, and the value of the site as a source of power will be doubled when the dams incidental to the Trent Canal construction are built across the outlets of Lake Simcoe at Washago, which is less than three miles above the plant, making the immense storage capacity of Lake Simcoe during available low-water periods.

FOREST PRODUCTS' LABORATORIES EXPAND.

The Forest Products' Laboratories, instituted last autumn by the Dominion Government in conjunction with McGill University, contemplates the enlargement of the department, and has applied to the university for the use of another building. The McGill authorities are quite agreeable provided that the Forest Products' Service is able to repair the building in such a way as to make it a safe place for the headquarters of the new department, until the extensive plans are carried into effect when the various exhibits and staff of the service would then be housed in one of the new buildings which may be erected.

The trouble with the building is that it is sinking in the same manner as the McGill Union buildng sank some time ago. At present it is propped up with large wooden beams and as it is erected either on the bed of the old Molson Creek or on the shifting clay or sand that has been found to be very prevalent in this locality, it would be a big job to dig down to rock bottom and put a new foundation under the building.

PORTABLE METAL BUILDINGS.

Metal buildings have always been much better than wood structures for contractors on railroad and other engineering work, owing to safety, convenience and other favorable factors which their use assures. The new all-steel and metal-clad buildings now being made by the Pedlar People of Oshawa, Ont., make it possible for contractors and others to equip themselves with metal buildings with the maximum of convenience and ease of erection. They are made of Toncan metal, and are portable. They are very handy, and are especially in demand for railway work, as tool houses, shelters, oil stations, freight and wharf sheds, lamp and storage houses, etc. A very favorable feature of these buildings is that they can be added to in 8-ft. lengths at any time. They resist fire, corrosion, thieves, vermin, etc., with reliability and assurance.

QUICK COMPUTATION OF WEIGHTS OF BARS.

To find the weight of square or flat iron or steel bars, "Iron Age" suggest's multiplying the sectional area of the bar by 10/3, which will give the weight in pounds per lineal foot. Add 2 per cent for steel. For example, in the case of an iron bar 1½ x ½ inches:—

3/2 × ½ × 10/3 = 5/2 or 2½ lb. per lineal foot.

For steel, add 5/100 = 2.55 lb. per lineal foot.

In the case of round steel bars, to find the weight per lineal foot, divide the square of the number of quarters of an inch in diameter by 6. For example, in the case of a steel bar ¾ inch in diameter:—

3 squared (three being 3 quarters) 9 divided by 6 = 1½ lb. per lineal foot.

SOME GOOD ROADS, THEIR CONSTRUCTION AND MAINTENANCE.

By Robert C. Muir, C.E.,
Mackenzie, Mann and Company, Toronto.

ONE of the chief requirements of our advanced civilization is good roads. This is proved by the growing demand for them. The excellence of the Roman roads still existing in various parts of Britain is direct proof of the high state of civilization to which the ancient Romans had attained, and it is admitted that no more reliable evidence can be given as to the condition of a people than that evinced by the quality of their roads, experience teaching that social, industrial and commercial development depend largely upon them.

Everyone interested in the question realizes that manufacturers, merchants and farmers save thousands of dollars through being able to haul their products to markets over an improved highway. This, the author considers the best reason for spending money on good roads.

The chief factor at the present moment is, Where is the money to come from to build and maintain good roads?

For reference the author will here explain the method employed by the Imperial Road Board of Great Britain for raising and apportioning money.

Imperial Road Board of Great Britain.—It was constituted under the Development and Road Improvement Funds Act, 1909.

The money derived from motor spirit duties and motor car license duties, imposed by the Finance Act (1909-10) is as follows:

Motor spirit excise duty of 6c. per gallon.

Manufacturer's license $4.85	Additional excise
Dealer's license $4.85	duty of $1.25 each.

Rates of Duties on Motor Cars.

Motor cycles and bicycles	$ 4.85
Motor cars not exceeding 6½ h.p.	9.70
Motor cars exceeding 6½ h.p. but not exceeding 12 h.p.	14.55
Motor cars exceeding 12 h.p. but not exceeding 16 h.p.	19.40
Motor cars exceeding 16 h.p. but not exceeding 26 h.p.	29.10
Motor cars exceeding 26 h.p. but not exceeding 33 h.p.	38.80
Motor cars exceeding 33 h.p. but not exceeding 40 h.p.	48.50
Motor cars exceeding 40 h.p. but not exceeding 60 h.p.	101.85
Motor cars exceeding 60 h.p.	203.70

The above-mentioned sums go to Road Board less cost of collection. The sum credited to the Road Board improvement fund for years 1909-10 and 1910-11 aggregated $5,806,720.

In 1910 the Road Board issued a circular as follows: "For guidance of highway authorities who contemplate making application for grants, the Board desires it to be understood that, at the outset, applications should be confined to those of the most important and urgent nature, and that special consideration will be given to those in connection with proposals dealing with:

(1) Reconstruction of important roads, the condition of which is exceptionally bad and cannot be improved without reconstruction.

(2) Widening of important roads which are dangerously narrow.

(3) Surfacing with granite, basalt, or other suitable material treated with tar or other bituminous compound by some approved method, main roads or important district roads which already have adequate foundations, especially those in or just beyond the fringe of large towns, which have to carry a heavy traffic without aid from rates of the towns served by the roads.

(4) Opening out dangerous corners and alteration of dangerous curves.

(5) Alteration, where possible at reasonable cost, of steep gradients.

(6) Strengthening or reconstruction of weak bridges, which seriously limit the use for commercial transport of roads of first class importance.

(7) Construction of new by-pass roads to avoid villages or main roads or important district roads where the conditions are exceptionally dangerous.

(8) Acquisition in urgent cases where building is imminent of vacant land required for future widening of roads, especially in urban or suburban areas.

Allocation of Grant.—The Board goes upon the principle of paying 75% of any approved scheme. First of all they must be satisfied that any proposed scheme will be beneficial to the through users of the road, and secondly, to the local authority charged with its upkeep.

This 75% is of the portion of cost which is extra over the ordinary yearly upkeep, that is to say, the average yearly upkeep is deduced from the total estimate of the scheme; then the Board pay 75% of the remainder.

This is the general principle with all county authorities, but the Board is not so generous with municipalities, where a grant of 25 to 35% is only occasionally allowed.

Specifications of Road Board.—The Board gives specifications for surface tarring, tar macadam, pitch grouted macadam, and No. 1 and No. 2 tars.

Tar Macadam Specification.—(1) Roads must have proper foundation.

(2) Thickness of surface should be ascertained by opening roadway.

(3) Thickness of tar macadam when finished should be from 2 to 3 in.

(4) Hard subsoils should have at least 6 in. of road crust foundation, and clay subsoils at least 11 in.

(5) Cross fall should be 1 in 32.

(6) The aggregate of the tar macadam should be of approved stone, at least 60% broken to 2½ in., 30%, 2½ to 1¼ in., and 10%, ¾ to ½ in., the last-mentioned to be kept separate and used as top dressing.

(7) The stone to be dried before coating with tar.

(8) Tar to be in accordance with Board's specifications Nos. 1 or 2.

(9) The quantity of tar to be from 9 to 12 gallons per ton.

(10) To be rolled smooth.

(11) Paint surface with tar after road has been open to traffic for some weeks.

(12) Surface to be gritted with ½ in. chippings.

Specification for Tar No. 1.—Tar should be treated to a temperature of 220° to 240° F. It should be derived from the carbonization of bituminous coal.

The specific gravity at 15° C. should be 1.19 or may vary from 1.16 to 1.22.

It shall not contain more than 1% of water, which water shall not contain more than 5 gr. of ammonia per gal. of tar.

Specification for Tar No. 2.—Tar should be heated to 260° to 280° F. It should be derived from the carbonization of bituminous coal. Specific gravity at 15° C. should be 1.21 or may vary from 1.18 to 1.24. The tar shall be free from water and shall yield no distillate below 140° C., nor more than 3% of distillate up to 220° C. Between 140° and 300° C. it shall yield not less than 15%, nor more than 21% of the weight of the tar.

At this point it might be convenient to mention that in Great Britain there are over 231,000 miles of roads, some of which, it is said, are the finest in the world, and for which the cost of upkeep in 1892 was $42,500,000. But last year (1913) the cost of upkeep was over $90,000,000. The number of motor cars is estimated at 240,000.

Various Kinds of Roads.—The engineer's problem of to-day is how to build and maintain good roads.

Macadam Roads.—These, when properly built and maintained, form the safest, pleasantest and cheapest road surface known for suburban streets and country roads.

The Telford and Macadam methods have given best results in a rather wet locality where the water has aided in binding the materials, and its removal by drainage of the roadbed and surface was the most important point in the maintaining of a good road. The said methods carried out in a locality having little or no rain, drainage is unimportant, and the preserving of a well-bonded surface is of the greatest importance. This bonding may be secured with a bituminous binder.

Points to be observed in construction of macadamized roads:

(1) The removal from roadbed of all vegetable matter.

(2) Subsurface drainage.

(3) Use of the very best material afforded by locality, and if traffic warrants it, the importation of suitable material.

(4) Classification of stone, 2½ in. down ½ in. chippings.

(5) Complete exclusion of loam and clay from stones.

(6) Use of stone dust and screenings, same quality of stone used to fill interstices.

(7) Thorough consolidation of stone by using a 10-ton steam roller.

Quality of Stone.—The material used for this class of road must naturally vary according to locality. Local stone, owing to cost of haulage, must generally be used. Should the traffic be excessive it will be found more economical to procure a superior stone, even at a greater cost than the local stone, in all cases where traffic is great, the best material obtainable is the most economical.

The qualities required are toughness and hardness—ability to resist the breaking up action of the weather.

A well-made and formed limestone road will be more impervious to wet than any other, having a detritus which acts like mortar in binding stones together and will not break up so soon in dry weather. Hardness without toughness is of no use, as a stone can be hard, yet so brittle as to be crushed to powder under a heavy load, when a stone not so hard but tough will be uninjured.

The author advocates the rolling of foundation and of each coat or layer of stone, the finished surface to be of chippings and dust of same quality of stone used, this to be watered and rolled until consolidated.

Watering.—Water expedites the consolidation, lessens crushing under the roller, and aids the filling of interstices with binder. The spray should be fine, a sprinkler being used, and not thrown on in quantity or by use of hose. Excessive watering tends to soften foundation and great care should be taken in applying it.

Rolling.—A steam-roller has proved to be the most economical. There is no rutting by wheels of vehicles, or holes wherein water can lodge; resistance is reduced to a minimum, saving wear and tear of horses and vehicles, and comfort of people using the roads. Roads should be made for the traffic and not by it. The use of a 10-ton steam roller for all purposes except asphalt construction, is strongly advocated.

Breaking of Stone.—Stone should be broken by hand, a practice which finds favor with many engineers in Britain. With this method of breaking, stones are more uniform in size, have sharper edges, are not flaky with rounded edges, and are therefore better for compacting. The installation of the machine breaker or crusher has effected a great saving in cost and also increased the output considerably.

In Canada, where labor is very expensive, the breaking of stone by crusher is undoubtedly the best method. The hand-breaking method, though the best, is very expensive. The wear and tear of crusher and also the initial cost are very great.

To be a paying factor, the crusher must be kept in almost constant use. Great care must be taken in feeding and must be placed so as to reduce to a minimum the cost of handling the broken and unbroken stone.

In many places a fixed plant is used for crushing, the stone being brought to the crusher. The haulage in this case may be very great, which increases the cost considerably. It is, therefore, generally more economical to take the crusher to the stone, and this is done by having a crusher of portable type and using the steam-roller to haul it.

Surfacing of Macadam Roads.—The methods employed in re-surfacing are:

(1) The surface is cleared from dirt and new stone spread on and rolled in the same manner as a new construction.

(2) The surface is scarified before new stones are spread on.

The object of this is to enable the new stones to become more compacted with old material.

As to its advantage much difference of opinion exists. Some engineers maintain that it is not good to touch the compacted surface for the questionable advantage of securing better union of old stones with new. Others are of the opinion that the surface should be scarified, the stones sorted and cleaned, and relaid with the addition of new stones. In deciding which of these methods should be adopted it is necessary to consider all the circumstances. The thickness of existing surface and nature of roadbed must be considered. In the case of a thick surface, the surface should be scarified, but great care is necessary, as should surface be broken through to roadbed the foundation is liable to be injured.

With a thin surface and weak foundation scarifying should not be done as it is liable to make the road weaker than before. The author having had experience in both methods has had good results from each, though he is in favor of not disturbing the existing surface, which is the general principle carried out in Britain.

Maintenance of Macadam Roads.—The opinion that no road is a good one unless when once laid it will take care of itself is ridiculous; there is no such road. The

essential point in the preservation of a good surface is the vigilance on the part of road authorities. Should a depression appear in consequence of settlement, defective material, or other causes, it should be immediately eliminated. Best results are obtained and money is saved by immediate repairs on the road surface rather than leaving it until practically worn. Roads must be kept clean and, if possible, dustless.

When a road is finished and opened to traffic, it cannot be left to take care of itself; if so, it will soon deteriorate. The systems of maintenance in vogue are: (1) Contract; (2) personal supervision by rural population; (3) men employed by road authorities.

The author is in favor of the system of the work being done by men employed by the authorities, as in his opinion the men become familiar with the section under their supervision, and also seem to take an interest in the work, doing their very utmost to keep road clean and tidy. This is the system carried out in Scotland and other European countries, and it is to the thorough appreciation of this fact that the excellence of their roads is due.

The contract system is very unsatisfactory from the difficulty of getting a proper observance of the terms of the contract from contractor; this system has been tried in many places and has never given satisfaction.

The personal supervision by rural population or the statute labor system is not applicable to the upkeep of improved roads. It is unsound in principle, unjust in its operation, wasteful in its practice and entirely unsatisfactory in its results.

The rolling of a road in spring, after frost is out and before roadbed is dry, is one of the best means of keeping a macadam road in good condition. As before mentioned, great care must be exercised in watering and a road should not be watered unless it really needs it.

Macadamized Road with Tar Binder.—The tar binder has given good results, producing a road almost similar to an asphalt surface, almost noiseless, less wear and tear, less mud and dust than ordinary macadam.

Asphaltic oil has been used in many places as a binder for macadam roads and in very dry climates has given satisfactory results. The following method is employed: The existing surface of the road is covered with coarse sand of ½ in. thick. The oil heated to a temperature of 175° F. is then applied and is allowed to remain for 24 hours. This surface is then covered with ½ in. of sand, and oil again applied. This surface is immediately covered with sand sufficient to fill the liquid oil and remove stickiness. The surface is then rolled. Should surface lift under this treatment a little sand is applied again.

One of the first experiments tried by the author was treating of road surface with ordinary gas-works tar. This certainly kept down the dust and as a surface binder was fairly successful. But in hot weather it was continually running, and was more of a nuisance than otherwise.

Another method tried and highly successful as a dust preventative: calcium chloride was mixed in the proportion of 1 cwt. chloride to 100 gallons of water, and the mixture sprayed on to the road. This material served the purpose well, the absence of dust within a given period (almost three weeks) being the subject of favorable comment by residents. The cost worked out at 25 cents per mile for chemicals only.

A thin coat of tar of under-mentioned specification gives a fine surface in dry weather, but becomes dirty in wet weather under heavy traffic. During summer this method is very successful if used on streets under light traffic.

Specification: Specific Gravity—1.19 at 60° F.; Water—free; Fractionation—not more than 3% at 220° C., 15 to 20% at 300° C.; Free Carbon—15%; Viscosity—30 sec. at 70° F. The cost of this treatment was 5 cents per sq. yd. One gal. of tar covered 5 sq. yd. of surface.

A few years ago the author had a section of road treated with Tarvia "A," which was an exceptionally heavy tar. This road surface was in every way good, very regular in shape. The method was carried out in the following manner:

1st, Surface of road was thoroughly cleaned and swept free of dust; 2nd, the tar was heated and spread on road by means of sprinkling cans; 3rd, chippings of same quality of stone used on existing surface, which was very gritty, ½ in. to ¼ in. in size, free from dust, was spread on surface; 4th, the surface was then rolled with a 10-ton roller. The section treated was opened to traffic a few days after completion. The quantity of tar used was ¾ gal. to 1 sq. yd. of surface. The following year a similar treatment was applied, with the exception that the quantity of tar used was ¼ gal. to 1 sq. yd. of surface. This treatment gave excellent results, openings made in road a few months after second treatment showing that tar had really penetrated the surface to a depth of one inch, which greatly helped to bind the surface. It may be mentioned that this section did not get quite a fair trial as traffic conveyed upon it mud and dust from either end of the section, which caused a little more sweeping and watering than was necessary.

Before applying the tar the surface of road must be thoroughly cleaned, all dirt being removed so as to expose the stone surface. Should the surface not be cleaned in manner mentioned, or any cakes of dirt be allowed to remain, the tar will not penetrate into the macadam.

Surfacing with a substance called "Cormastik" is another method which has proved satisfactory. It is composed of ¼ in. to ⅜ in. granite chippings, sharp sand, powdered sicilian rock asphalt containing 10% of pure bitumen and Portland cement. The binder employed is Cuban natural asphalt refined and suitably fluxed. The existing surface of road having been thoroughly swept and cleaned and painted with the bituminous solution. The "Cormastik" is then spread in a heated state to a thickness of one inch, a wooden straight edge being used for levelling, and finally rolled to a smooth surface by a 3-ton tandem roller.

This surfacing is also made up in brick form 9 x 4½ x 2 in. thick laid on a concrete foundation and suitable for heavy traffic.

Pitch Grouted Macadam.—The size of stones used was 2½ to 1¼ in. with chippings from ¾ to ⅜ in., the finished thickness being 3 in. The stone, spread and levelled, is rolled dry until proper surface has been formed. The pitch, after being melted, is heated to a temperature of 300° F. Clean, sharp sand is added to this, mixed thoroughly in mixing vessels and transferred from these into cans, from which it is poured upon the road. On this surface a thin layer of chippings is applied. The quantity of pitch used was 2 gal. to a sq. yd. of surface. This method is fairly satisfactory in some districts. In the author's experience the pitch boiled out in hot weather leaving the road in dirty condition. The crown of the road became bare of pitch, the sides getting

the surplus. The stones were never thoroughly coated, thus allowing water to get into the crust.

The method employed in one instance was a double layer. The size of stones used for the lower layer was 3 to 2 in. and for top layer 1½ in. with ½ in. chippings. The lower layer of stone is spread and levelled and is rolled dry. The pitch and sand mixture (as above described) is poured on, but not brought to surface. The pitch lying ½ in. or so below surface of the lower layer to form a key for top layer.

When the top layer has been laid, the pitch mixture is poured on surface, which is rolled and consolidated to proper shape. During rolling chippings are applied to form finished surface.

The quantity of pitch mixture used was 3½ gal. per sq. yd. for the two layers. The finished surface in this case was 4½ in. thick. This method was very satisfactory during the year, almost dustless, and not slippery during frost.

(To be concluded next week.)

ELECTRICAL DRIVING OF WINDING ENGINES AND ROLLING MILLS.

In a very complete and well-illustrated paper, delivered last month to The Canadian Society of Civil Engineers and to the Canadian Mining Institute, C. Antony Ablett, A.M.Inst.C.E., and H. M. Lyons, A.M.I.E.E., described the use of electrical machinery for driving hoisting engines in mines and reversing mill plants in steel works.

The first winders of importance were introduced in 1902, and the first electrically driven reversing rolling mill was installed in 1906, though non-reversing rolling mills were driven electrically some eight or ten years earlier.

The developments along these lines have been extremely rapid, as is shown by the fact that at the present time about one thousand large winding engines and nearly sixty reversing rolling mills are being driven electrically. The earlier winding engines were extravagant in power and had the disadvantage of drawing very heavily upon the source of electrical supply at the moment of starting. It was, therefore, impossible to use them on systems where the supply of current was limited, and even on comparatively large plants their use resulted in serious interference with other machinery. These disadvantages were, however, practically done away with when the Ward Leonard system and Ilgner's adoption of the flywheel to this system were introduced, but the last few years have seen greater improvements in the Ward Leonard and the Ilgner system.

The paper delivered by Messrs. Ablett and Lyons dealt chiefly with the developments of these systems by the various Siemens companies, who have installed about half the total plants in existence, and with whom the authors are associated, as general manager and assistant manager, respectively, of Siemens Company of Canada, Montreal. Following is a very brief abstract of the paper:—

In the Ward-Leonard system a direct current motor is used to drive the winding engine or rolling mill, the motor being supplied with power from a direct current dynamo, and the essential feature of this system is that the voltage supplied to the motor, and consequently the speed of the motor, is controlled by controlling the field current of the generator, instead of by varying the resistance in the armature circuit of the motor.

Thus, as the field current of the generator is increased from nothing to a maximum, the motor speeds up from standstill to full speed, and if the field current of the generator is reversed, the motor reverses its direction of rotation.

This system enables a very exact control of the speed to be obtained, because the speed of the motor is practically proportional to the strength of the generator field, whatever the load on the motor may be, while with any control system where resistances are inserted into the armature circuit of the motor, the speed would vary within very wide limits with a change of load, rendering the exact speed control quite impossible.

The control of the dynamo field involves scarcely any waste of electrical power, but where resistances are inserted into the armature circuit the loss of power may be, and usually is, very great. The field currents of the generator are small, so that the control mechanism is small, compact and very easy to handle, the armature currents are perhaps fifty times as great, so that any control mechanism which varies the resistance of the armature circuits is large, clumsy and difficult to handle, in fact a complicated relay system is often necessary to enable it to be handled at all.

The dynamo used to supply the motor in the Ward-Leonard system is usually driven by a motor supplied from the available power circuit, forming a motor generator set, and this motor may be either direct current or three-phase, according to the power available. The dynamo may be, and sometimes is, driven by an engine, water turbine, or other prime mover, if this happens to be more convenient.

The paper gives a full description of the application of the Ward-Leonard system to winding engines and hoists under the titles of Speed Control, Use of Flywheel, Details of Ilgner System, Brake Gear and Safety Devices.

It also describes the application of this system to reversing and three-high rolling mills, discussing power diagram for reversing blooming mill, action of flywheel, safety devices, etc.

A three-phase motor cannot be built for a very low speed without its power factor being bad, which tends to upset the regulation of the supply system, and for this reason where three-phase motors are driving winding engines they nearly always run at higher speeds than the drums, and are geared to them. In the Ward-Leonard or Ilgner system, however, where a direct current motor is used, this is almost invariably direct coupled to the drum. The three-phase system was described under the following headings: Control, Power Diagram of Three-Phase Winder, Comparison of Three-Phase Winder with Ward-Leonard and Ilgner Winders, Lowering Load, Starter and Controlling Resistances, Emergency Gear, Winding Men and Shaft and Rope Inspection.

As a number of winding engines have been equipped with three-phase commutator motors, an account of that system is also given.

The conditions governing the selection of the type of drum differ very considerably, according to whether the winder is to be driven electrically or by a steam engine. It is characteristic of the steam engine that its overload capacity is not very great and that the turning moment varies according to the position of the cranks. For a two-cylinder engine with cranks at right angles, such as is usually used for a steam winder, the minimum turning moment is .785 of the mean turning moment, and

the maximum turning moment is 1.112. The engine naturally must be able to start the hoist with the cranks in any position, so that the minimum turning moment must be at least sufficient to overcome the static load and friction. An electric motor, on the contrary, has a very large overload capacity in proportion to the mean power which it will give, and, consequently, the motor for winding engines is usually selected with reference to the equivalent continuous load, and it is very rarely indeed that the starting moment or acceleration peak needs to be considered.

The first type of drum to be employed for winding engines was the cylindrical drum, but later the conical drum was introduced. In some cases the latter gives easier starting conditions and is beneficial to the steam engine, because the rope supporting the cage at the bank top is wound off the greatest diameter, while the rope attached to the loaded cage at the pit bottom is wound on to the least diameter, so that the empty cage partially balances the rope and the loaded cage at the start of the wind.

The Koepe pulley winder is used to a considerable extent in Europe, particularly in Germany. It differs from any other type, as the rope is not wound on to and off drums but is carried over the pulley and makes contact with it for less than a single turn. Thus the rope from the ascending cage comes up the shaft over the driving pulley by the winder, and then down to the descending cage, being suitably guided by head sheaves.

It will thus be seen that the winding rope is driven by friction alone, and, consequently, there must be a very definite limit between the pull in the ascending rope and the pull of the descending rope, otherwise the rope will slip on the pulley, and, to keep the difference in pull of the two sides of the rope as small as possible, a balance rope is always necessary.

It should be noted that such a winder cannot work with a very high acceleration, otherwise slipping of the rope will take place. As the rope is bound to creep on the pulley to a certain extent, the depth indicator must frequently be reset to ensure its accuracy.

As with a Koepe pulley winder the axial length of the pulley is very short indeed compared with that of a drum on which the rope has to be wound, and as the weight of the winding drum is not increased by the rope which it is carrying, the moment of inertia of the revolving parts of a Koepe pulley winder is small, and this, together with the use of the balance rope, keeps the maximum acceleration peak comparatively small compared with that of other types of winder.

Generally speaking, the Koepe pulley winder shows to the greatest advantage with deep shafts as it avoids the use of excessively long drums, and, from the electrical point of view, where the winding speed is not very high and where the acceleration period is short compared with the total time of winding. It has the disadvantage that if the rope breaks, both cages are detached from the winder.

Table Showing the Influence of the Different Types of Drums on the Electrically Driven Winding Engine.

Depth 1,600 feet. Output 270 tons per hour.

	Cylindrical Drum	Conical Drum	Scroll Drum	Koepe Pulley
Power of motor	1,090	965	780	935
Speed of motor	84	66	62.7	97
H.P. per revolution ..	12	14.6	12.4	9.6
Maximum peak with Ward Leonard system	1,86[illegible]	1,600	1,300	1,276
Average loss of power with three-phase system	225 H.P.	260 H.P.	170 H.P.	241 H.P.

Generally speaking, the authors are of opinion that the Ward-Leonard or Ilgner system of electric winding is the most suitable for vertical shafts, and for all cases where large outputs are required and short and frequent winds are made. The three-phase winder always has the disadvantage that it cannot be so completely protected against careless handling as either the Ward-Leonard or the Ilgner, but it may prove more economical for long slopes where the full speed run is a long one and the periods of acceleration are comparatively infrequent.

Regarding the choice of drums for the winding engine, the authors are of opinion that in many cases where electrical drive is adopted, the cylindrical drum winder will prove the most suitable, but that in cases of deep shafts where the winding speed is high the scroll drum winder may prove better than the cylindrical drum winder, but that the field of application of the conical drum winder to electric winding is very small.

The authors have purposely avoided any comparison between the running costs of a steam and an electrically driven hoist or rolling mill, because each case should be considered on its own merits and comparisons made for one case will not be valid for another where conditions are different. No general comparison has any practical value, sometimes the steam engine is the more economical, and sometimes the electrical plant, according to conditions, and in deciding which is the more advantageous there are other factors besides running costs to be considered.

The authors are of opinion that direct current is much better adapted for driving mills and machinery in a steel works than three-phase current. Where large reversing rolling mills are driven electrically, and the motor driving the motor generator set is supplied from a direct current system, it is found that the power supplied to the rolling mill plant can be maintained at a much steadier value than if it is supplied from a three-phase system, and with the direct current motor about a ten per cent. saving in power can be effected, as there is no loss of power in slip resistances.

With a direct current system the flywheel of the motor generator set can be utilized to a great extent for neutralizing sudden peaks of short duration in the power demand on other parts of the system, for, during such a peak, the motor generator set would not only cease to take power from the supply, but the motor can be actually reversed, and give its full output as a generator returning the energy of the flywheel as electrical energy to the supply system.

With a three-phase system, peaks in other parts of the system cannot be neutralized to anything like the same extent, for the motor can only be made to cease to take power from the supply system and cannot act as a generator returning power to the supply system.

The direct current compound wound motor is very well adapted to fulfil the conditions for driving three-high merchant and bar mills and that considerable complication and difficulties are involved in adapting the three-phase motor for this purpose.

Direct current motors are also particularly well adapted for driving slow speed sheet and tinplate mills, and it is very easy to provide a slow speed direct coupled motor and gain the advantage and economy of this drive, and, as there is no loss of power in slip resistances, the direct current motor will prove from twelve to fifteen per cent. more economical than the three-phase motor on this current alone.

The advantages of direct current table and live roll motors are fully recognized, but it is interesting to note that in perhaps the largest steel works on the American Continent, where the main power supply is three-phase, all the table motors are direct current and a large and costly installation of converting machinery has been provided to convert the three-phase current to direct current to supply these table motors.

It may be argued that the cost of cables with a 500-volt direct current system is much higher than for a high voltage three-phase system, but it must be remembered that a well laid out steel works is comparatively compact and the distances are relatively short, so that the cost of cables is not a very serious item, and that the additional capital cost of three-phase generating plant to produce power, which is wasted in the slip resistance, etc., will pay for a good deal of extra cable.

In steel works where there are blast furnaces and coke ovens, the modern tendency is to install large gas engines using blast furnace or coke oven gas, both for driving the blast furnace blowers and for generating electrical power, and experience shows that a direct current gas engine power house is cheaper in capital cost and easier to operate than a three-phase power house.

Gas engine driven three-phase alternators present the most difficult problem in parallel running, and while sufficient experience has been gained in the past ten years to enable these difficulties to be overcome by proper design, the provision of very heavy flywheels is always necessary, and these largely increase the capital cost of the three-phase generators, which are intrinsically more expensive than direct current generators. The higher the periodicity the heavier the flywheels for the three-phase generators become. The 500-volt direct current system has found very wide application in the steel works on the Continent of Europe.

DIESEL ENGINE EXHIBIT AT THE PANAMA-PACIFIC EXPOSITION.

It is announced by the Department of Machinery of the Panama Pacific International Exposition that more than a dozen large firms have contracted for space in which to install engines built on the Diesel principle. These exhibits will occupy a central space in the great Palace of Machinery, and will be under operation through connection with electric generators or other machinery for the purpose of showing the efficiency and economy of working.

It will be recalled that the tragic death of Dr. Rudolph, inventor of the motor, by drowning in the English Channel, which occurred in September, 1913, was almost simultaneous with the final triumph of his ingenious motor by its adaptation to railway traction on a large scale.

NATIONAL IRRIGATION CONVENTION.

Arrangements are being made for a National Irrigation Convention to be held in Calgary next September. A fund of $20,000 is practically assured for it. The convention will bring a large delegation of irrigationists from Oregon, Washington, Montana, Idaho, Utah, Texas, California and other States. Irrigation work in Canada has created a good deal of interest in the country to the South, and the gigantic project of the Canadian Pacific Railway, as outlined in *The Canadian Engineer* for January 1st, 1914, will receive a thorough inspecting by many irrigationists who are extremely interested in the enterprise.

A detailed programme of the convention will be announced at an early date.

THE ZOELLY STEAM TURBINE.

In 1898, Mr. Zoelly designed a new type of steam turbine which resembled in many respects a water turbine of the impulse type. This machine was designed on the radial flow principle. The blades were not curved. A second machine with curved blades gave better results, however, the steam in this case striking against the rotor blades in radial direction. The principle of the impulse type has been adopted from the commencement as being the best, and the only alterations that took place were in the manner of guiding the steam onto the wheels. The turbine has gone through many stages of improvement which, however, have been solely of a constructional character. No departures from the adopted principle have taken place. On the original type the governing is effected simply by throttling the live steam and not by varying the number of channels through which the steam is admitted.

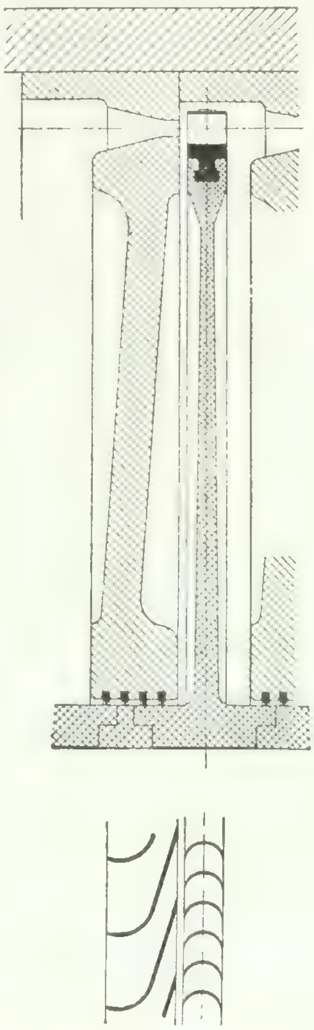


Fig. 1.—Runner and Guide Wheel of Zoelly Turbine.

This turbine has, in the past, been subjected to a good deal of criticism respecting the steam pressure and temperature in the first stage which were considered to be excessively high and which were supposed to have a deleterious effect upon the stuffing boxes. In the case of the present Zoelly turbines these criticisms are without foundation as in the first stage a greater pressure drop and likewise a correspondingly higher steam velocity is made use of than previously. This velocity equals or even surpasses that of sound corresponding to the steam conditions of this particular stage.

In order to be able to construct large units without having to employ too large blades in the last two stages, these stages are provided with a greater drop of pressure so that they also work with steam velocities which may be five and even more per cent. higher than the velocity of sound. The intermediate pressure stages work with steam velocities which do not, or only in a very slight degree, exceed the velocity of sound belonging to the conditions of these stages. At any rate, the excess of velocity over that of sound is in the intermediate stages never so great as in the first and last stages.

The total drop of pressure available has been divided up in such manner that it has been impossible to reduce the number of stages and thereby shorten the turbine by an appreciable amount. If necessary, these stages are constructed with expanded guide channels or nozzles. This expansion is not, however, designed for full load

but only for about half or a quarter of full load, in order to ensure a good efficiency even at part load. Such types of Zoelly turbines have been built since 1908.

The characteristic feature of the Zoelly turbine has always been the design of the runner wheels and guide channels in the diaphragm, the former of which, in spite of the high factor of safety required, are enabled to give a relatively high circumferential velocity. Consequently greater latitude is permissible in regard to the number of stages and speed of the steam in each case.

Construction.—From the commencement the Zoelly turbine has always been constructed with a horizontal shaft; experience with water turbines has shown that by this method the simplest form of bearing can be used, permitting an easy inspection at all times. In the case of turbines running at 3,600 r.p.m. a flexible shaft is used, so that the critical speed is sufficiently below the working speed; but in the case of turbines running at 1,800 r.p.m. and under, the contrary is the case, the shaft is rigid and the critical speed is above the working speed. The shaft is supported by two bearings which are lubricated by oil under pressure, and is connected by means of a rigid or flexible coupling (usually rigid) to the generator or machine to be driven. The casing is built up in two halves, the joint being horizontal, so that the rotor can easily be inspected without dismantling the bearings. An idea of the accessibility of all the important parts can be gained from the illustrations shown.

To keep the velocity of the steam low, which is possible in the simple velocity wheel, the wear in the blades, specially when working with saturated steam, is reduced to a minimum.

The impulse type allows large clearances in radial and axial direction. The axial clearances of the runner blades as well as the radial clearances are about 0.2 in. Nevertheless, the steam consumptions obtained with the Zoelly steam turbine are extremely low, particularly for the large size high-speed units.

The turbine is what can best be called a commercial machine, i.e., a machine giving with the greatest reliability best economy and least wear, with a minimum of attendance required.

The total thermodynamical efficiency obtained has been as high as 74%.

Since this turbine came on the market 11 years ago, it has done excellent work. Twenty firms are at present licensees of the Escher Wyss Company, of Zurich, who built the first machines and who have since supplied the bulk of the machines put on the market.

Up to 1913, Zoelly turbines of 3,350,000 h.p. have been supplied, of which those built by Escher Wyss and Company had a capacity of over 800,000 h.p. The largest size machine was 15,000 kw., equal to 28,000 h.p., of which two units were supplied to the Rheinisch-Westfaelisches Elektrizitaetswerk (Germany) — one in 1911 and the second as a repeat order in 1913.

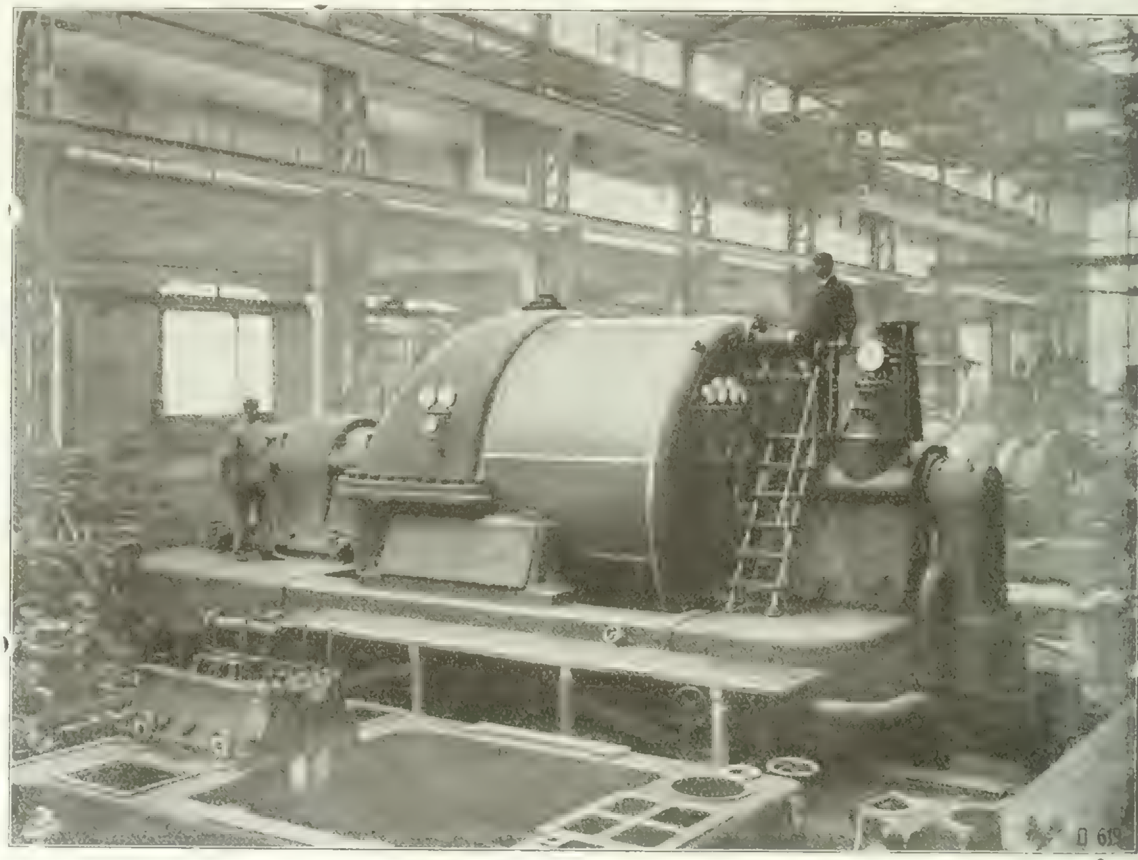


Fig. 2.—15000-kw. Escher Wyss-Zoelly Steam Turbine.

A number of machines of similar size have been built for other concerns; such as, a plant of four 10,000 kw. units for the Chile Exploration Company, of New York.

The *Engineering Record* describes the recent feat accomplished in subway tunnelling in New York city thus:—"For the first time in the history of subaqueous subway construction in New York city, a radical departure from the usual methods of building the tubes in place by compressed air tunnelling methods has been made. An 8,000-ton section of four-track steel lining, 220 feet long, 26 feet wide and 24 feet deep, which had been assembled and riveted on shore, was floated out into the Harlem River and sunk into position through 60 feet of water. The enormous mass was at all times under perfect control, was handled without any surges, plunges or violent or dangerous movements, and the structure was placed in position far below the surface without the use of guides or complicated apparatus. Work was carried out strictly in accordance with a detailed schedule of time and operation, which made ample provision for all the difficult conditions under which the work was executed."

Coast to Coast

Guelph, Ont.—The bridge leading from Riverside Park to Wellington Place and to the Guelph Country Club has been formally opened.

Victoria, B.C.—The civic board of works of Victoria has prepared estimates for 1914 calling for a requirement of $1,041,136.40, a considerable increase over the outlay in 1913 of $969,427.70.

Brantford, Ont.—By an overwhelming majority Brantford [illegible] ford Street Railway and Grand Valley Railway from Brantford to Galt for the sum of $253,000.

Vancouver, B.C.—With an expenditure of between $15,000 and $20,000, the C., M. and St. P. Railway Company has purchased its right-of-way at Sumas preparatory to linking up its line with the B.C. Electric railway, over which rails it will enter Vancouver until its own line is finished.

Toronto, Ont.—It is reported that the first of this month is to make the commencement of operations upon the harbor development scheme in Toronto. The great undertaking will be started at Ashbridge's Bay to the east of the mouth of the Don, where three piledrivers [illegible] to be supplemented by other drivers.

Hamilton, Ont.—At a recent meeting of the Hamilton Works Committee it was announced that the estimate of the Hydro Department for street lighting has been amended, the new figure being $88,125, whereas the original estimate was $64,200. It was explained that 25½ miles of streets had been added to the original estimate, and that some of these had to be lighted on both sides.

Vancouver, B.C.—Estimates recently furnished for 1914 on the partnership main between Point Grey and Vancouver, totalled $294,740, as compared with $213,394 last year. The principal increase is for submerged main maintenance. Under this head last year less than $1,000 was spent, but this year the replacing of the main on account of the government dredging is estimated to cost $100,000.

Ottawa, Ont.—On March 20, supplementary estimates, amounting to $3,257,036 for the fiscal year just ending, were tabled in the Commons by the Minister of Finance. This brings the grand total of the estimates voted for the year to almost $206,000,000. Of the supplementary estimates, the additional amount required towards the completion of public works was $264,204.

Ottawa, Ont.—The annual report of the Ottawa electric department has been recently submitted to the city council. The revenue for the year amounted to $191,648.64, as follows: domestic lighting, $68,032.27; commercial, $53,438.04; power, $26,978.76; street lighting, $32,637.73; ornamental lighting, $10,561.84. The expenditures totalled $142,283.54; leaving a gross surplus of $49,365.10, of which $24,000 was written off for depreciation, admitting a net surplus of $25,365.10.

Edmonton, Alta.—The extension of the P.G.E. railway into the Peace River district of Alberta, a line which, it is stated, will be a subsidiary road of the G.T.P. system, will start from the confluence of the Fraser and Salmon Rivers, following the latter to Summit Lake, thence along the Crooked River to Fort McLeod and McLeod Lake, thence along the Missinchinka River, through Pine Pass and along the Pine River to Hudson's Hope, following the peace River to the Alberta boundary, connecting with the McArthur railway.

St. John, N.B.—A conference was held recently at St John between the city commissioners and the members of the board of trade with reference to the Valley Railway extension and bridges. The outcome was the general endorsation of a suggestion that the road be allowed to end at the point it has reached,—e.g., Gagetown—unless it can be finished to St. John, as originally planned. The board of trade will, however, continue to deal with the matter and will probably send a delegation to Ottawa to urge further federal aid for the bridges which would have to be constructed on the extension to St. John as originally planned

Vancouver, B.C.—Mr. J. W. Stewart, president of the P.G.E. railway, has announced that employment will be given to 12,000 men this year on construction work. Three important contracts have been let covering the proposed Kelly Lake-Fort George line, which is some 280 miles in extent. Only 100 miles, however, are included in the contracts issued. As the contractors have just finished work on the G.T.P. railway at Fort George, the new work will begin at once, and it is expected that this entire section will be completed next year. The contract for the first 100 miles of the extension north of Fort George into the Peace River country will be let by the end of next month.

Toronto, Ont.—The following is part of a resolution which was carried unanimously on March 25th in the Ontario legislature: "In the opinion of this House, cheap and convenient electric railway transportation facilities is one of the most urgent needs in many rural sections and towns of the province, and this House would respectfully urge upon the Dominion government the importance of the question and the wisdom of encouraging the construction of municipal Hydro-Electric radial railways, and that this House further respectfully urge upon the Dominion government the great importance of co-operating with the province in the development of the water powers created by existing and projected canals now under construction and capable of development by the utilization of the waters necessarily supplied thereto and not required for navigation purposes."

Quebec, Que.—The Dorchester Electric Company, of Quebec, which has been in operation only about fourteen months, has completed its first year with a satisfactory surplus of $4,000; and the earnings for the first months of 1914 showed a rate much in advance of this, a surplus of $1,379 remaining after interest and other fixed charges were met. The company is extending its business substantially and is gradually cutting down operating expenses. The company's largest contracts are the lighting of the streets and municipal buildings of Quebec for a period of 10 years, a contract with the town of Montcalm for the same period, and a similar contract for Charlesbourg for the same period. The peak load which the company can carry is 1,640 h.p. At present customers are taking about 1,500 h.p. for lighting purposes; and the motor load is only 827 h.p.

Taghum, B.C.—The contractors for the Taghum bridge, Hodgson, King and McPhalen Bros., of Vancouver, are confident that the structure will be ready for traffic by May 1st. Work on the three main spans is being rushed to completion; and in addition to these, which are of truss design, there are two short spans to be placed in connection with the approach to the bridge from the south side. These, however, can be placed, no matter what the condition of the water may be. At present the contractors are exerting all their energies on the three main spans, so that these may be completed before any material rise in the water takes place. Costing in the neighborhood of $100,000, the bridge, which will be finished well within contract time, is almost entirely a product of British Columbia. Cement manufactured at Princeton, steel fabricated at Vancouver, and lumber grown in this province, are the materials which have been used.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page [illegible] a directory of such societies and their chief officials.

CANADIAN SOCIETY OF CIVIL ENGINEERS, OTTAWA BRANCH.

The last evening meeting for the season of the Ottawa Society of Civil Engineers was held on April 2nd, when Walter J. Francis, C.E., Consulting Engineer, of Montreal, delivered an address, entitled "The Engineer and the Public." The meeting was held in the Board Room of the Commission of Conservation, and was attended by 75 members. Mr. Francis advanced many arguments in favor of a united effort on the part of engineers to elevate the profession, claiming the best ways for accomplishing it to be a better education of the young man entering it, the maintenance of a proper standard of dignity, and perfection in the work of the engineer, and co-operation with fellow-engineers.

The address was followed by an excellent discussion, Messrs. R. F. Uniacke, C.E., C. R. Coutlee, C.E., Noulan Cauchon and others taking part. Mr. Geo. A. Mountain was chairman.

NOVA SCOTIA MINING SOCIETY.

The annual meeting of the Nova Scotia Mining Society will be held in Sydney, N.S. on April 14th and 15th. Indications are that it will be the most successful gathering in the history of the society. Addresses and technical papers have been prepared which will be read by a representative list of men in mining in the Maritime Provinces, and the programme gives evidence of a comprehensive review of the entire mining industry as applied to Eastern Canada. The principle topics under discussion will be electricity in mining and coal. The following is a list of some of the speakers together with the subjects which they will present:—

"Distillation of coal"—F. E. Lucas.

"Fletcher's unfinished work"—W. N. McDonald.

"Longwall machine mining"—J. F. K. Brown.

"Longwall development at Jubilee Colliery, Sydney Mines"—Robert Robinson.

"Electric motors for various services in the mining industry"—C. H. Wright, Halifax.

"Cinematographics and science"—Alexander Theuerkauf.

"A mining engineer of the fifteenth century. De Re Metallica Georgius Agricola, 1545"—F. W. Gray.

"Mine fatalities"—Robert Drumond, Stellarton.

"Use of typographical survey maps in mining"—R. Boyd.

"Shipping piers"—D. H. McDougall.

"Methods of mining two coal seams lying near together"—W. Herd.

"Coal as seen under a microscope"—A. J. Tonge.

It is expected that R. W. Brock, Deputy Minister of Mines, Ottawa, will be present and will deliver an address.

THE ROYAL ARCHITECTURAL INSTITUTE OF CANADA.

The 7th annual assembly of the Royal Architectural Institute of Canada will be held at Quebec, Que., on September 21st and 22nd, 1914. A very interesting programme is being prepared, which will include matters of interest to every Architect in the Dominion. The programme will be sent early in August to all the members of the R.A.I.C., and will contain all the particulars. The committee of arrangements of the Assembly is composed as follows: J. H. G. Russell, Jos. P. Ouellet, René P. LeMay, Albert R. Décary, and Alcide Chaussé, Hon. Secretary.

DINNER TO DEAN GALBRAITH.

The graduates of the Faculty of Applied Science and Engineering, University of Toronto, who are resident in Ottawa, held a dinner on March 28th, in honor of Dr. John Galbraith, Dean of that Faculty. The banquet, held at the Chateau Laurier, was attended by over 80 graduates. The function was most successful and great credit is due to the organizers. It is the first dinner of this kind that the graduates in engineering of the University of Toronto, who live in Ottawa, have held.

Prominent among the representatives from other centres were Major C. H. Mitchell, Consulting Engineer, Toronto, and a member of the Board of Governors of the University of Toronto; Professors C. H. C. Wright and T. R. Loudon, representing the Faculty of Applied Science and Engineering; Mr. J. L. Morris, Civil Engineer and Surveyor Pembroke, the earliest graduate of the institution; J. M. R. Fairburn, Assistant Chief Engineer of the Canadian Pacific Railway, Montreal; Walter J. Francis, Consulting Engineer, Montreal; G. H. Duggan, Vice-President of the Dominion Bridge Company, and others.

An important outcome of the gathering was the appointment of a local committee, consisting of Messrs. T. Shanks, J. B. Challies, R. S. Smart, F. D. Henderson, F. D. Withrow, P. F. Morley, G. H. Ferguson, J. L. Stacey and W. F. M. Bryce, to arrange for a permanent organization to take the form of Ottawa branch of the Engineering Alumni Association of the University of Toronto, and to be similar to the branches existing in various parts of Canada and the United States.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

AMERICAN SOCIETY FOR TESTING MATERIALS—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

MANITOBA ENGINEERING SOCIETY.

The Engineering Society of the University of Manitoba has recently issued the 1914 number of its official publication, "The Manitoba Engineer."

ARCHITECTURAL CLUB, UNIVERSITY OF TORONTO.

Plans for a power-house contemplated by the Water Power Branch, Department of the Interior, for the generation of electrical energy at Cascade River, near Banff, Alta., were drawn in competition in the Department of Architecture, University of Toronto. Of the resulting designs Mr. A. C. Wilson, a 4th year student, submitted the first prize winner. Mr. Merrill Denison of the 3rd year and Mr. Lester Husband of the 2nd year received the 2nd and 3rd prizes, respectively.

PERSONALS.

J. W. BATTERSHILL, at present in the City Engineer's office, Winnipeg, has just been appointed Engineer to the Municipality of East Kildonan.

R. A. BARRETT, Superintendent of the Toronto, Hamilton and Buffalo Railway, has just resigned owing to ill-health and has been succeeded by H. T. Malcolmson.

WALTER J. FRANCIS, C.E., consulting engineer, of Montreal, is at present on a trip to investigate sewerage and water supply problems in several cities of Western Canada.

H. T. ROUTLY, B.A.Sc., of Routly and Summers, left last week for Huntingdon, P.Q., to get his road machinery and equipment into shape for several large contracts which he has in hand there for this season.

WALLACE BROAD recently addressed the Engineering Society of the University of New Brunswick on "Engineering in China." Mr. Broad, an old graduate of that university, has spent considerable time in the Orient, and was for a lengthy period mining adviser to the Chinese Government.

ARTHUR L. MUDGE AND A. LEO MIEVILLE have become associated with Kerry and Chace, Limited, consulting engineers, Toronto, as managers of the electrical and mechanical branches, respectively. Mr. Mudge for over four years was chief electrical engineer for the Toronto office of Smith, Kerry and Chace, during which period they had charge of the design and construction of a large number of hydro-electric plants and long distance transmissions. For the past year Mr. Mudge has been chief engineer of the Midland Construction Company, which carried out most of the construction work for the Electric Power Company. He is first Vice-President of the Canadian Electrical Association and is on the library committee of the Toronto branch of the Canadian Society of Civil Engineers.

Mr. Miéville was at one time designer of high-speed machinery for W. H. Allenson and Company, Bedford, England, a firm for whom he acted until recently as engineer in Canada. Previous to this, Mr. Miéville had been assistant engineer upon the construction of the Winnipeg hydro-electric development, and turbine designer with the I. P. Morris Company, Philadelphia. Before leaving England, Mr. Miéville was for several years engaged upon paper mill engineering, and latterly in marine work, designing engines, turbines and general machinery for British and foreign admiralties.

OBITUARY.

CHARLES L. SMITH, General Manager of the Oregon Short Line Railroad, died last week at St. Catharines, Ont.

IRON AND STEEL OUTLOOK IN THE UNITED STATES.

The outlook for the iron and steel business in the United States is somewhat mixed. Orders on the books of the various mills at the beginning of April show a falling off as compared with the beginning of March, and a slowing down of operations is observed. This is more especially the case among the smaller than the larger producers. For prompt delivery, prices of the heavier lines, such as shapes, plates and bars, for second quarter contracts, are quoted at $1.25 Pittsburg, as against $1.20 for the first quarter, the efforts on the part of the mills to advance the price of the former $1 over the latter having failed. However, there has been a little more activity in the Eastern States for iron. No. 2 Birmingham iron has gone off 25 cents a ton, wire rods 50 cents and steel bars $1, as compared with the prices a week ago. On the other hand, a report comes from Pittsburg that the prices of billets and steel bars have been advanced $1 a ton to $22 and $23, respectively, at the mill, sales at these prices having taken place. In the East the market for finished steel is practically at a standstill, while a marked slowing up is observed in the Western markets for sheet and cast-iron pipe. While prices are keeping up well, the spring demand for wire products is expected to be below normal.

HOOK FOR MEASURING TAPES.

This hook, when attached to the first end of a steel measuring tape enables one person to take long as well as short measurements readily, while ordinarily two people are required; one at each end of the tape. It is a new article just put out by the Lufkin Rule Co. of Canada, Limited. It is a substantial, nickel plated hook with serrated face, and is designed so that it can be instantly attached to the first end of ¼ in. or ⅜ in. wide steel tapes. The hook grips the end of the article to be measured, and is so constructed that when attached to the first end of any regular tape measuring from the end of the ring, the zero point falls exactly at the inside of the hook so that measurements obtained are accurate. The hook can be as readily detached from as attached to tapes, in no way interfering with the use of the tape in the regular manner.

Vitrified Clays, Limited, announce the removal of their Calgary offices from the P. Burns Building to 236 Laugheed Building.

The offices of the Toronto Harbor Commission have been moved from the Bell Telephone Building to a more spacious location in the Otis-Fensom Building, 50 Bay Street, Toronto.

The city of Vancouver laid the following lengths in miles of pavements during 1913, according to the recent report of Mr. F. L. Fellowes, Supervising City Engineer:—Asphaltic concrete, 1.161; bitulithic, .248; granitoid, .179; brick block, .124; concrete, .026; wood block, .462; total, 2.200 miles.

The record of the Department of Labor for February shows that there was a pronounced decrease in the number of days lost through strikes and lockouts, as compared with the previous month, although the number was somewhat larger than for the corresponding month of last year. The decrease was largely due to a settlement of a strike of shoe machine workers in Quebec, about 3,000 employees returning to work on February 14. There were altogether seven disputes in existence in Canada during February, as against five in January and nine in February of last year. About 23 firms and 4,400 employees were involved in these disputes. Approximately 66,[illegible] working days were lost [illegible] th 117,450 during January, and 42,880 during February of last year. Three disputes commenced during February, none of which were serious from the standpoint of numbers affected. They were all, moreover, of short duration. The dispute of coal miners on Vancouver Island and garment workers at Montreal remained unsettled at the end of February.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21534—March 24—Amending Order No. [illegible], dated December [illegible], by striking out words and figures, "Between Southeast Quarter of Sec. 9, and Northeast Quarter of Sec. 16," in description of crossing No. 8 in operative part of Order, and substituting therefor words and figures, "Between the S.E. ¼ of Sec. 16 and the N.E. ¼ of Sec. 9."

21535—March 24—Authorizing C.P.R. to connect with its main line, Lake Superior Div., Cartier Subdivision, the spur of Mond Nickel Co., Limited, at mileage 103.25 of main line, in Lot 8, Con. 5, Tp. Dowling, Dist. Sudbury, Ontario.

21536—March 24—Authorizing G.T.R. to operate trains across fifty-seven (57) bridges.

21537—March 23—Authorizing G.T.R. to construct two (2) bridges—namely, No. 29, mileage 83.50 19th Dist., over Grand River, nearest station, Paris; and No. 21, mileage 76.02, 19th Dist., over Brantford and Tilsonburg tracks, nearest station, Brantford. all in Province of Ontario.

21538—March 24—Authorizing G.T.R. to construct bridge No. 257, at mileage 25.25, 13th Dist., in town of Milton, Ont.

21539—March 23—Authorizing G.T.R. to construct five (5) bridges, on its 12th District, Province of Ontario.

21540—March 23—Authorizing G.T.R. to construct siding into premises of Pelleyrino Del Sole, on Lot 105, parish of St. Bruno, Co. Chambly, Que.

21541—March 25—Suspending, tariffs and supplements applicable to international traffic, filed by G.T.R., M.C.R.R., Wabash, R.R., C.P.R. and P.M.R.R., pending hearing, to be fixed by Board, at which said Cos., will be required to justify said removal of Essex Terminal Ry. from joint tariffs, at present in effect.

21542—March 4—Authorizing Cedars Rapids Mfg. and Power Co., of Montreal, to take additional width of 25 ft. for its right of way for its transmission line, making in all a width of 125 ft. across certain lots known as Lots 262, 266, 267, 268 and 269, parish of St. Ignace du Coteau du Lac, property of Idala Charlebois; and Lot 183, parish of St. Polycarpe, Co. Soulanges, property of Charles Houle.

21543—March 19—Authorizing G.T.R. to expropriate lands between Yonge and Cherry Sts., Toronto, Ontario.

21544—March 24—Approving and authorizing clearance at G.T.R turntable at St. Thomas, Ont.

21545—March 24—Authorizing G.T.R. to reconstruct Bridge No. 328, carrying its railway across Vanstone's Pond at mileage 143.14, 6th Dist., near Lansdowne, Ontario.

21546—March 23—Approving revised location of G.T.P. Branch Lines Co.'s Regina-Moose Jaw Branch through north half of Sec. 28-17-20, W. 2 M., mileage 2.10 to 3.11, Dist. Regina, Sask.

21547—March 25—Authorizing G.T.R. to operate trains over interlocking plant at Paris Jct., Ont., without their first being brought to a stop.

21548—March 23—Approving location C.P.R. station at Denhart, on its Bassano Easterly Branch Line, in N.E. ¼, Sec. 2-20-11, W. 4 M., Alberta.

21549—March 24—Directing that G.T.R. submit for approval of Board a plan showing location of new station at Summerstown Station, Ont.; that Co. provide adequate and suitable accommodation for receiving, loading, unloading and delivering of all traffic offered for carriage upon its Rly., at Summerstown; erection of station be completed and facilities be provided by July 1st, 1914.

21550—March 24—Authorizing city of Fort William to construct, at its own expense, highway crossing over G.T.P. Ry., where Stanley Ave. would intersect said railway, Fort William, Ont.

21551—March 24—Directing C.P.R. to reappoint station agent at Beverly Station, Sask.

21552—March 25—Authorizing Board of Highway Commissioners for Government of Sask., at its own expense, to construct highway crossing over C.N.R. in N.W. ¼, Sec. 31-26-13, W. 3 M., at west end of station grounds at Forgan, Sask.

21553—March 21—Amending Order No. 21332, dated February 4, 1914, by exempting from operation of the Order the land of H. Strong, Tp. Bathurst, Co. Lanark, Ont., subject to certain conditions, that Rly. Co. (C.P.R.) erect return fences and cattle guards on H. Strong's farm crossing.

21554—March 24—Authorizing C.P.R. to construct spur for city of Moose Jaw, Sask., on Subdivision Lots 27, 28, 29 and 30, Block 127, city of Moose Jaw, Sask.

21555—March 26—Authorizing the Cedars Rapids Manufacturing and Power Co. of Montreal to take additional land for its right of way for its transmission line across certain lots in the parish of St. Joseph de Soulanges, Co. Soulanges, Province of Quebec.

21556—March 24—Authorizing the C.P.R. to construct road diversion in Sec. 34, Twp. 20, Rge. 7, W. 2 M., Sask., at mileage 100.3, McAuley Subdivision of its line of railway.

21557—March 25—Authorizing the Niagara, St. Catharines and Toronto Ry. to construct, maintain and operate a siding for the Electric Steel and Metals Co., Limited, in the town of Welland, Ont., and to construct said spur along Lincoln Street and across Denistoun Street.

21558—March 26—Authorizing the Toronto, Hamilton and Buffalo Ry. to construct, maintain and operate a temporary branch line of railway, or spur, on Lot 2, in the Broken Front Concession of the said Twp. of Barton, extending from a point marked "O-H.B." on the T.H. and B. branch line of railway serving the National Steel Car Co., Limited, and running thence northeasterly through the lands of the said National Steel Car Co., into and across the lands of Sir H. M. Pellatt, to and into the lands of the Dominion Power and Transmission Co., to a point marked "9-50 end track;" said branch line to be constructed and completed within six months from date of this Order.

21559—March 27—Extending the time within which the Campbellford, Lake Ontario and Western Ry. may use the crossing of the C.N.R. in the east half of Lot 12, Con. 4, Twp. Scarborough, Co. York, Ont., at mileage 0.35, until March 27th, 1915.

21560—March 26—Refusing application of the town of Forward for order directing C.P.R. to move its station; ordering C.P.R. to construct a spur at Forward, Sask.; commencing at a point on its Ry. just east of the distant semaphore and running eastwardly for a distance of five hundred feet; said spur to be constructed and completed by June 1st, 1914.

21561—March 31—Certifying that correction of book of reference endorsed on C.P.R. plan dated June 24th, 1911, to show Henry L. Auger as owner of portions of lands lying between stations 70-99 and 73-25 and between 73-91 and 75-16 respectively, instead of C.P.R. Co., is allowed.

21562—March 27—Authorizing C.P.R. to construct extension to spur for Hyde and Sons, Limited, in city of Outremont, Que.

21563—March 27—Authorizing G.T.R. to construct siding, subject to terms and conditions in by-law No. 74 with exception of condition No. 7, commencing at a point on 19th Dist., of its Rly. south of Allanburg Station, thence in a southwesterly direction upon, along and across Water Street (not opened). in village of Allanburg, Co. Thorold, Ontario.

21564—March 30—Authorizing Board Highway Commrs., for Government of Saskatchewan to construct, subject to terms of consent on behalf of C.N.R., at its own expense, highway over right of way and tracks of C.N.R. in N.E. ¼, Sec. 8-48-25, W. 3 M.

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COMMERCIAL DESIGNING OF STRUCTURES

MONEY CONSIDERATION NEXT IN IMPORTANCE TO THE GOVERNING FACTOR OF STRENGTH—SOME INSTANCES OF EXPENSIVE DESIGNING—A CRITICAL ANALYSIS OF COSTS.

By DANIEL J. HAUER
Consulting Engineer and Construction Economist

THE highest function of an engineer is that of designing. A man with limited ability and education may be able to carry out the plans and designs of another, but the broader and higher the education of an engineer, together with a well-balanced experience, the greater should be his ability in designing.

The world knows much of the structures and appliance of such greater designers and inventors as Sir Christopher Wren, Watt, Stevenson, Bartboldi, Eiffel, Roebling and Westinghouse, although it knows little of the men who carried out their designs. The names of the greater designers of engineering structures and machines live in the history of the world, but to few of those who carry out designs, i.e., the builders, does this apply. Goethals, of Panama, is an illustrious exception.

In all designing there is need for care and accuracy. The lives and welfare of many people are dependent upon the work of designers. There should be two standards of designing in every country. One should be for work done by the general government, in which the standard for excellence should be of the highest, represented by strength and artistic lines and finish.

Cost and service should not be the governing factors. Representative structures of this kind abound in the old world, in the many cathedrals, palaces, memorial arches, parks and boulevards, and in America the number of similar magnificent structures is increasing.

The second standard should be for commercial structures, for which the first consideration should be strength, the second cost and service or utility, and the last, art. However, art should not be sacrificed for a few cents, or when an artistic finish can be had for the same money for which an unsightly structure can be reared. In all commercial designing, all governing factors should give way to cost, except that of strength. This cost is not only that of construction, but also of service and operation, for it is manifestly wrong to design a structure for cheapness of construction that will not serve its purpose, or will cause a high cost for operation.

It is to be regretted that there are many instances occurring annually of engineers sacrificing strength for money considerations. Only a few years ago the sad spectacle was recalled in a paper before a technical society, of an engineer acknowledging that owing to money considerations, he had designed an important structure with such a low factor of safety that it had failed, wrecking very valuable property and causing heavy loss of life.

Buildings under construction fail, dams are washed out and many other engineering structures go down owing to faulty designs, insufficient strength being given to the designs through errors of judgment, lack of knowledge of designing, and sometimes to incomplete surface and sub-surface surveys, and data upon which to base the designs.

Such things are either directly or indirectly the fault of engineers. Directly, when they can control their work, or they undertake designing for which they are not fitted, and indirectly, when they cannot control their work, by not being furnished ample funds and time for surveys or are interfered with by governing boards and bodies, and they do not protest against such restrictions. Engineers under such circumstances should put their protests in writing and if conditions are not then remedied, they should refuse to go on with the work. Engineers should remember that in continuing under these circumstances, they are no longer living up to the high standards of their profession, but are injuring both their profession and themselves, for they suffer in reputation, while others escape all odium.

Beyond these considerations, money and service should be the guide of all commercial designing. Many designs will serve the same purpose, but some are much more expensive from either a construction or operation standpoint than others.

Some years ago, in designing some pile bridges for a railroad the plan called for a tenon on top of the piles to be mortised into the caps. This added to the cost of construction and of renewals, while it did not add to the strength. Drift bolts and lag screws formed the ordinary method and proved satisfactory for this purpose. Mortise and tenon work is used in frame structures, but owing to the extra cost the tendency is to substitute cheaper joints that will give the same strength and longer service, as a mortise is a hole to catch rain water and start decay.

A revolving drawbridge of the bob-tail type, i.e., with but a single span, was designed by an engineer, and to counterbalance the weight of the span, he designed heavy steel members on the end opposite to the span, as in the space provided for concrete he could not get enough of that material to serve as a counterbalance. A more experienced engineer cut out of his design several

tons of high-priced structural steel, and substituted a like amount of scrap iron and steel to be mixed with the concrete, at a cost of only a few cents per pound. The utility of the structure was the same, the cost of construction much less.

A mechanical engineer designed an elaborate and expensive, but an ingenious and economical, set of cranes and devices for charging a reheating furnace and serving a steam hammer with ingots of a certain kind. It was afterwards found that it was not possible to work these ingots with that hammer. Here was a waste of money due to designing without having complete knowledge of the work in question. A few dollars spent on experimenting with the ingots in question with this hammer, would have prevented this error.

More than a decade ago a bridge being built in Canada failed owing to a pier sinking in the river as soon as the false-work was removed, owing to incomplete sub-surface surveys. This was a great waste of money due to faulty design of the foundation, based upon insufficient knowledge of the soil under it. Additional time and money spent in exploration would have prevented the failure.

Failure during construction does not always mean poor design. A few years ago an engineer had to build more than a mile of shore protection along a bay. He designed four types of walls and decided upon a design of concrete protection that was 50% cheaper than any of his other designs. He was severely criticized because about 200 feet of his shore protection failed, while being constructed under adverse conditions. Yet, this slight loss amounted to only a few hundred dollars, while he had saved more than $10,000 by the accepted design.

When the entire structure was finished it had ample strength to serve every purpose, and has proven this by some years of use.

Sewers are designed with many shapes, some of them extremely fantastic and expensive to build. Even with steel forms that are used over and over again for concrete sewers, some shapes make the cost of construction excessive. An odd shape does not add to the value of a sewer, but rather detracts from it, for the shape of the sewer should be designed for strength, available head room, and for the easiest flow of the sewage through it according to the gradient. This is also the case with conduits and aqueducts. If these considerations are followed in designing, then the costs are not likely to be excessive. When one considers the thousand miles of sewers that are needed in America, the need of an economical design of conduit is at once apparent.

Because concrete can be moulded into almost any shape, is not sufficient reason for making odd and expensive designs, not only in sewers, but likewise in any concrete structure. A railroad company asked for bids upon a number of concrete structures to replace stone masonry. The engineer had designed these concrete structures just as though they were built of stone, i.e., the wing walls had steps in them and the back of the walls and abutments had a series of steps and offsets varying from two inches to a foot, all of which meant extra costs for form work, adding nothing to the strength, as the same purpose would be served by a batter to the walls.

During the past year the writer made a visit to more than a dozen concrete bridges under construction, with a view to making economic studies of the work. It was quite surprising to note that only one engineer in designing his bridges had taken into consideration the methods of construction, and without sacrificing strength, had made his design so that thousands of dollars were being saved in construction, especially in forms. The centering timber used on one job had previously been used on three other bridges, to the superintendent's knowledge, and he stated that it was not new then. The cost of forms for concrete is always a heavy item. When their cost can be reduced it is the duty of the engineer to so design his structures.

This does not mean that graceful lines and architectural beauty should be excluded from the design. There can be ornamental panels, balustrades, columns and arches, as these structures are not only meant for service but to beautify. On the other hand, it is a waste of money to design and build ornamental panels, when they are to be covered over with vines, or the structures are so situated that they cannot be seen. A city once paid to have some bridges in a park made of ornamental design, only to allow their consulting landscape gardener to cover them with ivy. The ivy-covered bridges were pretty, but the costly ornamental panels were hidden, leaving only the graceful lines of the concrete bridges to be seen.

In designing structures the service of sewers, bridges and similar structures, is simple, i.e., they are for a single purpose. But it is not so with buildings and other edifices. Here the engineer must consider many things as regard to service, the problems being more complex. First of all, the purpose for which the building is to be used, should govern the lighting of the structure. The error in most cases is that of not having enough light, or having it enter at the wrong place or angle. Space that is too valuable may be given over to lighting, without obtaining the proper effect. At times the error may be to make the light too intense. These things apply to both sun and artificial light. A building to be used as a warehouse for storing goods does not present a difficult problem in lighting, but a school building, library, public hall, department store and factory gives the designer a very complex problem, and the success of the entire project may depend entirely on the lighting.

Money can easily be wasted in such cases. Few designing engineers and architects have given this subject study enough to solve such problems unaided, so they should call upon the services of expert lighting engineers, whose business is that of lighting alone.

In designing buildings for manufacturing, the various steps of the work to be done should be considered. The work should be planned first, and then the building designed to suit. Thus floors are generally built on the same level, while if different levels are used, chutes may carry the material from one machine to another by gravity, saving either machinery or the transferring by hand. The arrangement of rooms and floor space for machines should be in accordance with the sequence of the work so that material will not be handled unnecessarily. These arrangements should also be made in connection with the lighting system, for ample light means quicker and better work.

Store rooms for raw materials should be arranged at the place from which the material is to be worked up, and storage places for the finished products should be at the opposite end. This seems simple, yet it is a detail that is often overlooked, these store rooms being located with a view of easy handling, rather than for economical handling within the plant.

A few years ago a large manufacturing plant was to be rebuilt. The owners first employed a firm of economists to make a study of their methods of manufacturing and to devise a more economical method. This done, the engineer and architect drew up plans under the supervision of the economists. Many things were designed different from the ordinary standards and even a lighting engineer was employed. The result was that operating costs were cut nearly 25%, while the cost of building was reduced 10%. All waste room was cut out, and few later alterations had to be made.

This was in contrast to a large saw mill that was destroyed by fire and rebuilt last year on the same general plan as before. All the finished product has to be carried the entire length of the mill to be placed in the storage yard.

These examples illustrate how many engineers overlook the service feature of their structures, and how money is thus wasted in building and in operation. Both the old and the young man engaged in designing will do well to consider these important things.

MUSKOKA RIVER STORAGE.

The sixth annual report of the Hydro-Electric Power Commission contains some information on the watershed of the north branch of the Muskoka River, lying in the districts of Muskoka, Parry Sound, and Nipissing, and comprising an area of about 560 sq. mi. above Port Sydney.

The report, which has just been issued, is for the year 1913. One of the important chapters it contains is that devoted to the hydraulic investigations that have been carried out during the year. The data on stream flow and storage possibilities of various rivers in the province are steadily accumulating, and represent the acquirement of hitherto unavailable knowledge that is most important in the development of the water powers of Ontario. F. A. Gaby, B.A.Sc., is chief engineer to the commission, while H. G. Acres, B.A.Sc., and T. H. Hogg, B.A.Sc., are hydraulic engineer and assistant hydraulic engineer respectively. The following data relates to their work up to October 31st, 1913, on one of the many rivers under investigation, and outlines a projected scheme of improvement whereby storage and complete regulation of flow may be effected:

General Conditions.—Until recently, the paramount industry in the territory mentioned above has been lumbering, and for many years the north branch has been used for the transportation of saw-logs. Under ordinary conditions, log-driving seriously hampers power development, but a peculiar feature of the situation as regards the Muskoka River is that injury is now being caused not through the activity of the lumbermen, but through the cessation of their operations in the upper watershed. This is due to the nature and location of the lake areas.

In the lower portion of the watershed is a group of four large lakes, all but one practically on the same level. In the upper watershed is a large number of small lakes, which have in the past been controlled by lumbermen's dams. When lumbering operations were at their height, large quantities of water were held in these upper lakes, and they were flushed out more or less in succession in bringing drives down the main river and out of tributary streams. The water thus liberated discharged into the group of larger lakes above mentioned, and through their capacity for storage they reduced and equalized the various flood peaks, and discharged them more gradually into the lower river. As the lumbering industry waned, the quantity of water stored in the upper lakes was reduced, and the dams began to suffer from lack of maintenance, the result being that an increasing proportion of the spring run-off discharged naturally into the lower basin, and drained off in the early part of the summer.

The result has been that, while power has been developed upon the river on the basis of a minimum flow which existed 10 years ago, the minimum flow during the last three or four years has dropped as low as 120 sec.-ft. at High Falls, or less than half the flow which was ordinarily supposed to obtain 10 years previous. A large part of the capital invested has on this account become unproductive, and long and frequent periods of inadequate service have caused much trouble and inconvenience, as well as a serious loss of revenue.

The object of the investigation is to determine to what extent artificial storage can be used to improve present conditions.

The oldest established industry in the Muskoka River watershed is lumbering, but owing to the fact that practically all the pine has been cut, the waters of the north branch are now very little used for driving purposes, and in two or three years' time, the use of the waters for this purpose will practically cease.

The navigation interests are confined almost exclusively to the handling of local tourist traffic and through tourist traffic to the Lake of Bays. Open navigation exists between Huntsville and Peninsula Lake, and connection with Mary Lake is made by means of a lock.

Several passenger steamers are kept in commission during the tourist season. The largest boat on the Huntsville-Portage route is 125 ft. long, 22 ft. beam and has a maximum draft of about 7 ft. The largest boat on the Mary Lake route has a maximum draft of 6 ft., and has a length and beam specially adjusted for the dimensions of the lock.

As to the commercial use which may in future be made of these waters for navigation purposes, it would seem that the limit of their utility would be the bearing of a tourist traffic not very greatly in excess of that now existing. This opinion may be justified on the following grounds:

(1) That the cutting out of the pine timber has destroyed any lake commerce that has previously existed in connection with the lumber industry.

(2) That the desertion of farms in the townships bordering on these lakes indicates that they will be used less in the future, in connection with the commercial needs of agriculture, than they have been in the past.

(3) That the continual opening up of new tourist districts by the railways will tend to check any abnormal expansion of the tourist traffic out of Huntsville.

It will be assumed, therefore, that the requirements of navigation will be adequately met by providing for the permanent accommodation of boats similar to those now operating.

The minimum depth of channel between Huntsville and the Portage will, therefore, be 8 ft., and 7 ft. between Fairy Lake and Port Sydney.

Power.—In the year 1892, the town of Bracebridge put its No. 1 hydraulic plant in operation in the Muskoka River, a 16-ft. head being developed for lighting load

only. This plant is now used exclusively for municipal pumping. In 1901, plant No. 2 was built, and a 250-kw. unit installed. In 1908 it was found necessary to add a 300-kw. unit. In 1909, the growing demand for power led to the building of No. 3 plant at Wilson's Falls. This site is now developed to full capacity, 600 kw. being installed. At the present time, the town has over 2,000 h.p. of wheel capacity installed, and a continuous market demand of 1,500 to 1,800 h.p. Under the low water conditions which have obtained during recent years, about 25 per cent. only of this installed capacity has been capable of use, and for weeks at a time the town has been obliged to carry a commercial load of 1,800 h.p. with a maximum plant output of about 550 h.p.

It is quite evident that the continued occurrence of these periods of power shortage would ultimately ruin the municipal system, as manufacturers would be forced to install a more dependable type of motive power.

In view of the above, it is unnecessary to emphasize the urgent need of improving the flow characteristics of the north branch of the Muskoka River. The obvious means of effecting such improvement is by the storage of surplus run-off in the navigable lakes, or in the smaller lakes of the upper watershed.

Storage Possibilities.—The choice of initial storage development lies between the group of four navigable lakes above Port Sydney, and a larger number of very much smaller lakes on the upper watershed above Lake Vernon.

As regards the latter, the complete development of the larger lakes would provide approximately 60,000 acre-ft. of storage. To obtain this, it would be necessary to repair and maintain seven to ten timber dams. Owing to the small storage capacity of the individual basins, more or less constant attention would be necessary for proper operation, and the inaccessible location of most of these basins would be detrimental to operation, both as regards cost and efficiency.

Another disadvantage consists in the fact that stored water from the upper system of lakes must pass through and be partially absorbed by the large lakes above Port Sydney. The influence of wind and temperature on these lakes will make it impossible to foretell with any degree of accuracy what effect the flushing out of a basin would have on the regimen of the lower river, or in what time the effect would become noticeable.

The obvious solution of this latter difficulty is, of course, to use the navigable lakes as auxiliary storage basins. This has actually been done through the agency of the government dam at Port Sydney.

Having established the fact that the navigable lakes must in any case be used to some extent in connection with any storage scheme that may be devised, the question arises as to whether the storage of these lakes could be developed sufficiently to dispense altogether, or in part, with the necessity of developing the upper system.

The combined area of the four lakes involved is such that about 10,000 acre-ft. of storage is available for each foot in rise. The importance of obtaining the maximum possible range of variation in level is therefore evident, and the whole point at issue is to determine a range of variation which will, on the one hand, cause no extensive damage by flooding, and, on the other, permit minimum navigable levels to be permanently maintained.

Results of Surveys.—The investigations of this problem necessitated the making of surveys covering a new site for a dam at Port Sydney; flood contours around Mary Lake; surveys, with soundings, of various channels. These surveys were of service in reaching certain conclusions which may be summarized as follows:—

(1) That the maximum regulated level of Mary Lake could be held 3 ft. above the ice level which obtained at the time of the survey, without causing undue damage.

(2) That the maximum regulated level above the lock should be held at, or slightly below, high-water level, corresponding to about 8.5 ft. on the upper sill of the present lock.

(3) That a 3-ft. variation of level above the lock, during the navigation season, will not injuriously affect navigation or riparian owners.

(4) That a 4-ft. variation of level below the lock during the navigation season will not injuriously affect navigation, and will not cause serious injury to riparian owners.

New Construction and Improvements.—The existing dam at Port Sydney is a wooden structure built by the Provincial Government for maintaining navigation between Port Sydney and the lock. This dam now requires to be replaced, and, in the interests of economy and efficiency, a permanent structure should be built. The lock between Mary and Fairy lakes is in a dilapidated condition, as is also the dam. The useful life of the dam might be prolonged by extensive repairs, but the lock requires to be entirely rebuilt. All new construction at this point, whether lock or dam, or both, should be permanent.

In the narrow channels between the lakes, the backwash of the boats cuts away the banks, and the consequent silting up of the navigable channels necessitates frequent dredging. This silting action could be effectively stopped by pile sheeting the exposed sections. The whole length of the channel between Fairy and Peninsula lakes should be treated in this way, and also certain portions of the channel between the lock and Mary Lake.

All of the above new construction is required in the interests of navigation, and any additional features of design in connection with these structures, which might be necessary in order to adapt them for storage regulation, would be insignificant from a cost standpoint. The surveys also indicated that the storage capacity of the lakes above Port Sydney could be economically increased by deepening some of the connecting channels between the lakes.

Details of General Scheme.—The dam at Port Sydney is to be designed so as to enable the levels of Mary Lake to be held between El. 23 and El. 27 during the navigation season, and to allow for an additional drop of two feet during the fall and winter. The bottom of the navigable channel between Mary Lake and the lock has been set at El. 16. A small amount of excavation may be necessary through the sandbar at the mouth of the river. Some soft dredging will also be required just below the lock.

At the lock, it is proposed to drop the lower guard sill to El. 15, and the mitre sill to El. 14. The upper guard sill is dropped to El. 23, and the mitre sill to El. 22. There will thus be 8 ft. of water on the lock sills under the minimum projected summer level.

With a tight permanent dam at Port Sydney, a permanent dam at the lock is not absolutely necessary, and present requirements will be met if the latter is repaired and alterations made which will enable it to hold the level above the lock within the extreme limits of variation, El. 34 max., and El. 29 min.

The general scheme provides for a navigable channel 60 ft. wide, with a minimum depth of 7 ft., between Fairy Lake and Port Sydney, with 8 ft. minimum on the guard sills of the lock, so that an 8-ft. channel could be provided in the future by dredging.

The adoption of the scheme would make 3 ft. of draft available in summer, and 2 ft. additional in winter, upon Vernon, Fairy and Peninsula lakes, making in all 5 ft. of draft available. Under similar conditions, 4 ft. of draft will be available on Mary Lake during the navigation season, and 2 ft. additional in the winter, making 6 ft. available in all. The combined area of Vernon, Fairy and Peninsula Lakes, is about 7,600 acres. The area of Mary Lake is about 2,600 acres. On the basis of the above figures for area and storage draft, the four lakes would provide 32,800 acre-feet of storage during the navigation season. The benefit to be derived from this volume of storage will be proportional to the length of the low water season, which will vary from year to year. The continuous supply from storage alone, for seasons of various lengths, would be as follows:—

107 days	from July 17 to Oct. 31	 155	second-feet.
92	" Aug. 1 to Oct. 31	 179	"
76	" Aug. 1 to Oct. 15	 210	"
61	" Aug. 1 to Oct. 1	 271	"

Under the worst possible conditions that could be imagined the watershed of the Muskoka River above Port Sydney should produce a natural minimum run-off of one-tenth of a second-foot per square mile of watershed. This would mean a natural low-water discharge of 56 sec.-ft. at Port Sydney.

If the flow from storage under various conditions be superimposed upon this natural discharge, the figures given above will become 211, 235, 274 and 327 sec.-ft. respectively. These latter figures fairly cover the range of benefit to be derived from the utilization, during the navigation season, of 32,800 acre-feet of storage on Vernon, Fairy, Peninsula and Mary lakes.

As to winter storage, it has been assumed that 2 ft. additional could be drawn off the lakes after the close of navigation. Assuming no fall replenishment, there would be 20,200 acre-feet of storage available, to meet low-water conditions during the winter. Two months' use of winter storage would probably cover the worst condition; say, from January 15 to March 15. Over this period, the above specified volume of storage would provide a continuous flow of 169 sec.-ft., which, superimposed upon a natural minimum of 56 sec.-ft., would mean a continuous supply of 225 sec.-ft. under the worst winter conditions to be anticipated.

The outstanding points of advantage in the above scheme are the greater accessibility of the works, and the vastly greater degree of precision with which the flow can be regulated, if properly designed works are placed at the lock and at Port Sydney. The facilities thus afforded for efficient regulation would more than offset any advantage the upper lakes might have as regards aggregate storage capacity.

The complete development of the storage of the lower lakes will also allow the storage of the upper lakes to be properly utilized at very small cost, should the necessity arise. It would simply be necessary, in this case, to keep the wooden dams in a fair state of repair, and to flush out the various small lakes in rotation whenever the stage of the lower lakes was such as to permit the reception of the additional supply.

The cost of operating and maintaining the upper system under such circumstances would be comparatively insignificant.

In conclusion it may be noted that the development of artificial storage for power purposes on navigable lakes is not by any means a new idea. The navigable lakes on the Trent and Rideau systems have been used for storage purposes for years, and the range of level variation which obtains on the navigable lakes included in both of these systems is much greater than that contemplated in the case under discussion. Furthermore, in the case of the Trent Canal a through navigation route is involved, where the interests of shipping will be of vastly greater importance as compared to those of power than they can ever hope to be on the lakes above Port Sydney.

CYANAMID FACTORY AT NIAGARA FALLS.

THE problem of artificially fixing atmospheric nitrogen and combining it in suitable forms for plant food has been a difficult one for scientists and one which has had their serious thought and attention for many years. In 1895 two German scientists, Drs. Frank and Caro, found that when nitrogen gas is conducted through a hot mass of calcium carbide there is produced a compound known as Cyanamid, very rich in nitrogen.

This form of combined nitrogen was found to possess particular value as a fertilizer and its use for this purpose has developed an enormous industry. Cyanamid factories have been established all over the world. One of the largest of these is located at Niagara Falls, Ontario,

New Addition to the Plant, at Present in the Process of Construction.

where large quantities of electricity, required in this industry, can be obtained at low cost.

The American Cyanamid Company owns the sole right to manufacture and sell Cyanamid in America. Its factories at Niagara Falls began operations on January 1st, 1910. The original plant had an output of 12,000 tons a year, but this was increased during 1912 to approximately 32,000 tons a year and further extensions are under way to give an annual output of 64,000 tons.

From the very commencement of operations at Niagara Falls it was clear that a plant capable of producing 12,000 tons per annum was totally unable to meet the market requirements, but a policy was adopted to thoroughly prove the commercial practicability of, and demand for cyanamid before building a large plant.

After two years' experience they realized that the product could be looked upon as an undoubted commercial success. Methods of manufacture have been simplified and cheapened, and it is now necessary to double the existing plant in order to cope with the increasing orders.

View of Complete Plant, Showing Lime en route to Kiln.

Nitrogen is the most important of the plant foods. It is usually the first element to become deficient in cultivated soils, yet when good forms and proper amounts are furnished, crops respond to it with a more direct and immediate effect than to application of phosphate and potash.

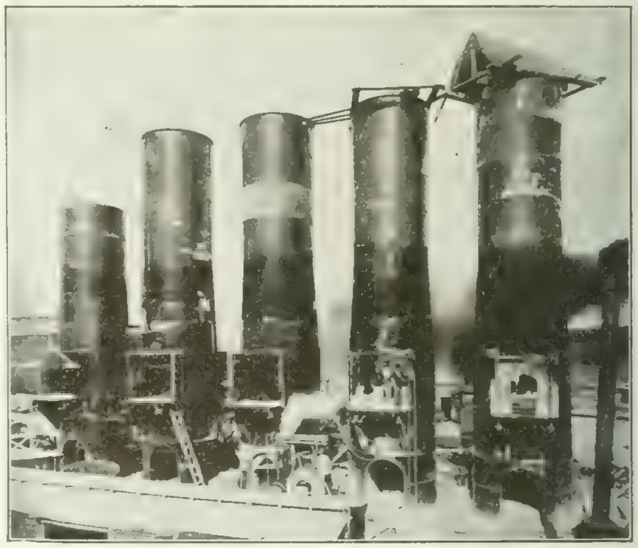
All the combined nitrogen now in existence on the earth's surface came from the atmosphere at some time. Previous to the discovery of cyanamid the only practical means of directly fixing atmospheric nitrogen was by the action of bacteria. These bacteria, themselves living on plants or plant refuse, take nitrogen from the air and combine it into chemical forms that plants can absorb. If plants were not removed, but were left to decay where they grow, the fertility of the soil would probably never decrease. When crops are removed, however, not only is the nitrogen carried away but also the plant matter on which the bacteria feed. Then, in order to maintain fertility, it is necessary to restore combined nitrogen to the soil from other sources.

Cyanamid is a bluish-black, odorless, powdered material. It contains from 18 to 20% ammonia, about 12% carbon, or lamp-black, and the equivalent of about 70 pounds of slaked lime. The material is shipped in burlap bags and can be stored indefinitely.

Cyanamid nitrogen is readily soluble. Ninety-six per cent. will dissolve out in cold water and is therefore available as plant food. On contact with the soil it reacts quickly and forms first the organic compound, urea, and then changes into the form of double ammonium compounds. These compounds are not leached or washed out of the soil, but are made available to crops by bacterial action and the solvent effects of plant roots. This action insures a slow, steady supply of nitrogen that has the advantage of not overfeeding crops a few weeks and then starving them, but of supplying this element throughout their principal period of growth. Since the soil duration of cyanamid nitrogen is from 60 to 80 days, crops are not fed when they should be maturing, and therefore ripen earlier and more uniformly.

Every 100 pounds of cyanamid contains the equivalent of about 70 pounds of slacked lime, which adds considerably to its value as a fertilizer. This line costs the farmer nothing—cyanamid is sold on the basis of the ammonia it contains as determined by analysis.

The beneficial action of lime is well known. Briefly its advantages are as follows: (1) It corrects soil acidity and produces conditions favorable for the growth and



Kiln Shells Being Erected and Fire Clay Lining Commenced.

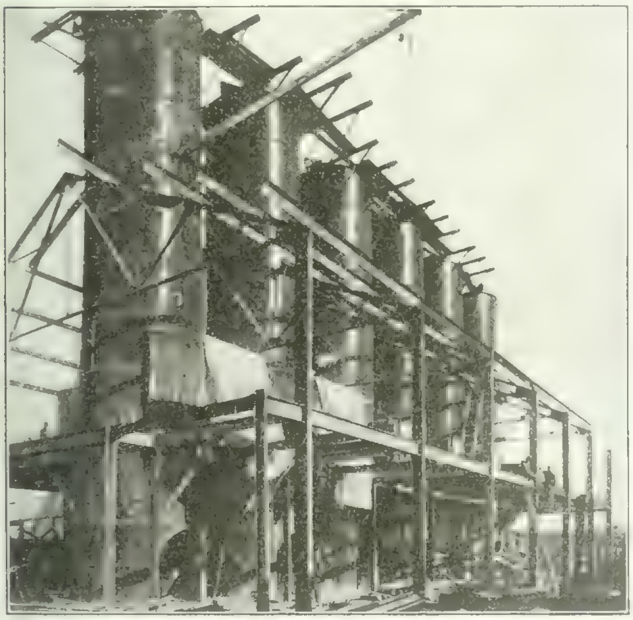
activity of nitrifying bacteria, which supply plants with much combined nitrogen. These bacteria are destroyed by acid conditions, but thrive in limed soils. (2) Lime

General View of Plant.

hastens the decomposition of waste products used as manures. (3) It destroys many injurious insects and soil diseases. (4) It makes available the phosphoric acid and potash often held too firmly in combination by some soils. (5) It improves the mechanical condition of all soils, making clay more porous and sand more retentive.

A regular application of cyanamid to soil in good condition should ordinarily neutralize the acids occuring therein. The ease with which the lime content of the soil is kept at a desired point makes this fertilizer especially valuable. Many other fertilizers tend to increase soil acidity until finally heavy liming is necessary. The yearly addition of lime as a part of the cyanamid fertilizer involves no extra expenditure of time, labor or money.

The manufacture of cyanamid depends upon the chemical fact that calcium carbide at a high heat combines with atmospheric nitrogen and forms calcium cyanamid. Calcium carbide is made by fusing together



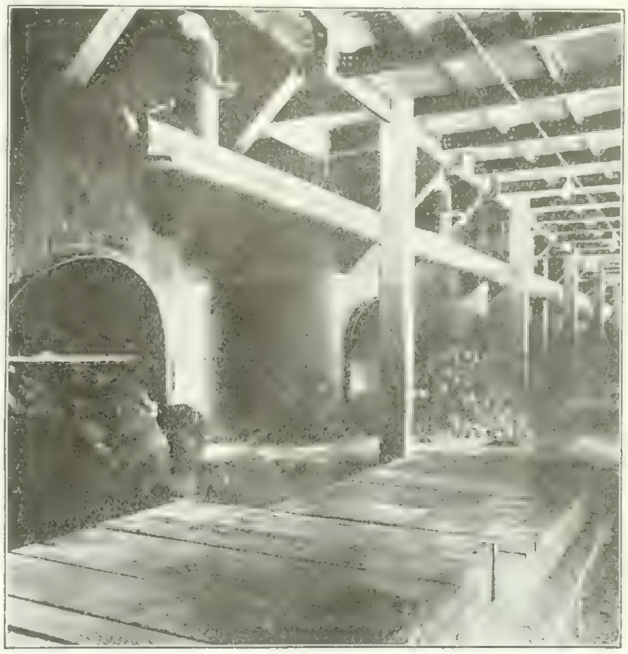
Kiln Shells Completed and Piping Being Installed.

lime and coke in an electric furnace. The carbide is placed in the ovens heated by electricity to a white heat and nitrogen is led into the ovens and is there combined with the carbide, forming calcium cyanamid. After cooling, this material is ground, treated with water and put through a mechanical finishing process.

It will readily be seen that for economical production of cyanamid the plant must be located where electricity can be secured at the lowest possible cost.

Before the installation of the cyanamid plant at Niagara Falls another matter of importance was to determine the kind of reducing gas to be used in the preparation of the nitrogen. After careful consideration a coal gas plant was decided upon as the entire output of coke could be used in the manufacture of calcium carbide and the coal gas gave the greatest amount of carbon content for use in the nitrogen ovens.

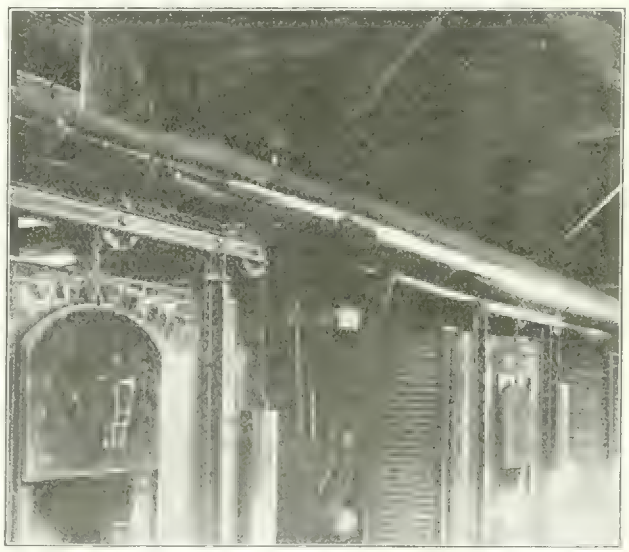
The nitrogen ovens consist of a series of vertical retorts heated by small individual furnaces. Copper oxide is placed in these retorts, and when the retorts are brought to the proper temperature air is forced through the retorts and the oxygen of the air combined with the copper and cupric oxide leaving the nitrogen free. The air is then shut off and as the oxide has gradually become foul during this cycle coal is then passed through the retort, which acts as a revivifier for the reducing agent. The nitrogen is then forced through pipes into the electric



Lime Discharge Floor, Showing Handling Arrangement.

furnaces where it combines with the calcium carbide and forms calcium cyanamid, or commercial cyanamid.

The lime plant for the manufacture of lime to be used in the cyanamid plant was designed and installed by the



Arrangement of Charging Doors of Kilns.

Improved Equipment Company. The original plant consisted of six Doherty-Eldred lime kilns equipped with the Eldred process and induced draft.

[illegible] their usefulness has not as yet been fully demonstrated.

SOME GOOD ROADS, THEIR CONSTRUCTION AND MAINTENANCE.

By Robert C. Muir, C.E.,
Mackenzie, Mann and Company, Toronto.

(Concluded from last week's issue.)

Brick Pavements.—Brick pavements, though used extensively in Europe for over 100 years, have only quite recently come to be used in this continent, the first being laid some 20 years or so ago. At first failures were numerous, these failures being due to poor foundation or the quality of brick. In Europe this form of pavement has proved highly satisfactory, and found in many places to be superior to stone blocks. Rotterdam and Amsterdam being two cities almost entirely paved with brick, here the brick for extra heavy traffic is imported from England and local brick used for light traffic.

The advantage of brick pavements are:—

(1) Easily cleaned.
(2) Easily repaired.
(3) Makes traction easy.
(4) Good foothold for horses.
(5) Durable under all kinds of traffic, granted foundations are good.
(6) Little dust and no mud.

The chief defects are: (1) The lack of uniformity in the brick; (2) noise.

The clay that the bricks are made from must be free from lime; thorough grinding and mixing of clay is essential, so as to have no lumps on the brick. A solid foundation is here again absolutely necessary, a weak foundation being often the cause of failure in all pavements. The foundation in every case should be formed of concrete (1:4) 5 inches thick.

Methods of Construction of Brick Pavements.—*Pavement on Brick Foundation.*—The roadbed should be graded to 11 in. below finished surface, then rolled until thoroughly consolidated. On this bed should be spread a layer of ashes to a depth of 3 in., then rolled. A covering of sand is then applied of sufficient thickness to form a cushion to the proper shape for receiving the bottom or foundation course of brick. This being satisfactory, place the foundation course of brick, long side parallel with curb, laid close and all joints broken. Dry sand should be spread over this and thoroughly brushed to fill all crevices.

Another layer of sand 1 in. thick is laid on to form cushion for top course of brick. This course will then be laid with longest edge surface across street at right angles to curb, laying brick as close as possible and breaking joints, no half-bricks being used unless where necessary to break joints. The surface should be then covered with sand, well brushed, and then rolled. The bricks used to be of the best quality, uniform and regular in shape and free from cracks.

Brick Pavement on Concrete Foundation and Grouted with Pitch.—The roadbed should be rolled and thoroughly consolidated and prepared to receive a layer of ashes 3 in. thick. The concrete foundation is then laid, depth varying according to traffic (5 in. is reckoned to be sufficient for medium traffic). The surface is to be made parallel with the finished surface of the pavement by floating the concrete surface over with cement and using straight-edge. Traffic should be kept off while concrete is setting, and brick should not be laid thereon for at least 4 days. When foundation is ready to receive brick lay a cushion of sand 2 in. thick. On this lay bricks on edge at right angles to curb, as close as possible, joints to be broken and then rolled with a 5-ton roller. The bricks having been rolled to perfect surface, the crevices are then filled with pitch heated to 300° F. and entire surface covered with a depth of ¼ in.; upon this spread a layer of sand ¼ in. thick. Sand must be thrown evenly on boiling pitch, and with no delay as pavement is finished, the object being to make the pavement one solid mass, which when finished shall be watertight. The sand to be used must be clean, sharp and free from moisture.

The sizes of bricks commonly used are 8¼ x 4 x 2½ in. and 9 x 4 x 3 in.

Rumbling.—Rumbling is caused by open spaces between brick and foundation. If sand cushion is not properly compacted, the settlement will leave an opening between cushion and brick, also an opening may be caused by course of brick being forced up off sand cushion. This may be caused by the swelling of lime used as joint filler. To avoid this upheaval it is advisable to place expansion joints every 25 ft., across the street and along each curb, and filled in with pitch. This is only necessary in a case of lime or cement joint.

Tar Macadam.—This is a method used extensively in Britain within the last 4 years.

Mixing.—In making tar macadam the stones should be thoroughly dried and heated, care being taken not to overheat. While hot they should be mixed with tar in the proportion of 8 gals. per ton, and mixed by machine. Opinions differ as to size of stones for this method some holding that the stones should be from 2¼ to ¾ in., so that all crevices may be properly filled. This would be quite acceptable if it were possible to have stones so evenly mixed that a proper proportion of each grade would be evenly distributed in every square yard of roadway, but this perfect grading is seldom realized, with the result that the road surface is of unequal strength. The author adopted the system of using only one size of stone for one particular piece of work, the best results being got from stones of 2¼ in. size. The smaller stones are used for very light traffic, chippings being used as a binding coat, and also for gritting the tar-finished surface. The cost per ton of making tar macadam, including stone, tar, heating, wages and carting is $2.00. This will, of course, vary with the cost of stone, price of tar, and efficiency of tarring and drying plant.

Laying.—The existing surface is scarified, evenly raked and hard rolled; this surface to be perfectly dry. Then tarred stone is spread on 4 in. thick, if a 3-in. finished surface is required. Should weather be very hot, light rolling should be applied to get stones into position, otherwise the steam roller may push the stones in front of it, thus causing a wavy surface, which is difficult to cure. When rolled hard a small sprinkling of tarred chippings will help to bind surface. After traffic has been on road for a few weeks the surface should be carefully swept and painted with a prepared tar. This class of surfacing is perfectly satisfactory on a fairly well-bottomed road with a good subsoil. The cost of this method of surfacing for a 3-in. finished surface is 40 cents per square yard.

Another method which has given good results is by the use of "Tarmac," the aggregate of which consists of furnace slag. The slag is run in a molten state from the surface into suitable receptacles and is allowed to cool. When cool the slag is removed to a convenient location and broken to suitable sizes before being put into the crusher. Thence it is broken to the regular sizes and afterwards treated with the tar composition. The

slag having had no opportunity of absorbing moisture is, therefore, perfectly dry, no extra heating being required. The slag breaks with a rough and uneven fracture and has great holding capacity for the tar composition. It is, moreover, sufficiently porous to absorb and hold a portion of composition.

The size of stone used is 2¼ to ⅜ in. chippings. The existing road surface having been prepared, spread a 4-in. layer of 2¼-in. stone and roll until thoroughly consolidated. Upon this spread a layer of 1½-in. stone, which is rolled and consolidated, making a total thickness of 4 in. This surface is thoroughly brushed over with ⅜-in. chippings, which are also coated with tar so as to fill all crevices, then rolled to a smooth surface, this finished surface to receive a covering of chippings.

Tarmac has proved satisfactory. It is almost dustless during summer and not unduly slippery during winter.

Bituminous Tar Macadam.—Where roads are subject to fairly heavy traffic something better than ordinary tar macadam is required. The author two years ago experimented on a road having a traffic density of 160 tons per yard width per day of 24 hours, which was unsuitable for ordinary macadam. With a bituminous macadam the surface in summer is excellent, but in winter the wear is pretty heavy as the protecting surface is torn off by wheels of large motor buses, especially with a thaw after a night's frost. The tar used was to the following specifications:—

Specific gravity	1.19 at 60° F.
Freedom of water	Practically free.
Fractionation	3% at 220° C., 15% at 300° C.
Free carbon	15%.
Viscosity	30 seconds at 70° F.

This was mixed with 20 per cent. of best Mexican bitumen, and after being down a few weeks, was surface coated with the same mixture and gritted with very hard chippings. Three different qualities of stone were used: (1) a very hard, keen stone, standing a great crushing strain; (2) a good, hard stone, but not so keen as first; (3) a good, moderate stone. By experience it was found that the keen stone had not taken a proper grip of the tar, and the suction of motor wheels tended to bare this stone by removing the particles of tar, which in cold weather had become pulverized by heavy traffic; the good hard stone holding the tar better, and the moderate stone being best of all, the more expensive being no advantage.

This roadway a year later was treated with tar and bitumen, part being treated with Mexican proprietory bitumen, which did not give such good results as tar and bitumen. This is the best tarred work the author has tried for a heavy traffic road.

The cost per square yard of this method worked out as follows:—

	Cents.
*Material and mixing	41
*Laying stone and binding	9
*Surface painting	5
	55

* Including labor.

Rocmac.—This binder is a silicate-saccharate-carbonate, the foundation of which is silicate of soda, sugar and carbonate of lime. The sugar is not used for adhesive purposes, but to assist the chemical action of the silicate on the carbonate, and secondly to assist the resistance of the matrix to frost.

A matrix is formed of the mixture in the proportion of ⅓ cu. yd. of crushed limestone to 5 gal. of Rocmac solution with an addition of similar proportion of water. This is mixed similar to the making of concrete, the limestone crushed to ¼-in. gauge and dust. This matrix is applied to existing road surface to a thickness of 1 in. for a finished 3-in. coat. The stone is then spread on and rolled until the matrix comes to surface. All superfluous material is swept off and surface left clean and hard.

The advantages of Rocmac are:—

(1) Repairable in almost any kind of weather, except hard frost.

(2) Cheaper than bituminous macadam (method above described).

(3) No yearly surface painting required.

(4) Dust not so obnoxious as from tar.

(5) Good foothold for horses, not so slippery as tar macadam.

(6) When laid, frost has not injurious effect on it as upon other road surfaces.

The defects of Rocmac are:—

(1) Dustiness in summer, though after superfluous limestone has been washed off dust is greatly reduced.

(2) Hard, metallic ring.

It is claimed that the life of Rocmoc road is 3 times that of an ordinary water-bound macadam road. The cost of Rocmac was 52 cents per square yard.

The author's experience has been that with roads laid upon a clay subsoil, imperfect drainage and under a medium heavy traffic tar in any shape or form soon gave out. After careful consideration he came to the conclusion that Rocmac, though not ideal in every way, was well suited to roads under said conditions.

Asphalt Pavements.—Asphalt is by no means a modern pavement, having been used in Paris about the year 1830 and introduced in London in 1860, or thereabouts.

Foundation is of the greatest importance with asphalt pavements, a solid foundation being absolutely necessary. Asphalt is commonly laid on a concrete foundation. 5 in. thick, though good results have been obtained from old macadam and brick pavement being used as foundation, which reduces the cost considerably. Foundation must be thoroughly dry before asphalt is laid, this being a most essential point in asphalt paving. Should asphalt be laid on a damp foundation it will break up as soon as traffic goes on it. Dry weather is, therefore, necessary for the laying of asphalt.

Asphalt cement pavement is composed of the matrix and the aggregate, success depending upon the selecting of materials, mixing and laying of pavement. The matrix is a cement prepared from asphaltum. The aggregate is composed of sand and stone dust, though in many districts Portland cement has been used in place of stone dust. When Portland cement is used more asphalt cement can be used, thus making a denser mixture, which tends to lengthen the life of pavement. The matrix and aggregate are heated separately to a temperature of 280° to 300° F. and are then thoroughly mixed.

The binder, which contains 5 per cent. more cement than finished surface, is then spread on foundation 1½ in. thick and rolled until consolidated. The finished surface is now applied and spread with rakes to a thickness of 4 in., if finished thickness is to be 2 in. This surface is covered with cement to prevent the roller lifting asphalt, and rolled to a perfect and uniform shape. When the road or street is curbed, asphalt should not be laid right up to the curb, but a gutter of brick or cement formed.

General Remarks.—Planning of Streets and Roads.—(1) New main roads should [illegible] side rather than

through towns, and where existing main roads are unsatisfactory for through traffic a new road should be substituted.

(2) Grades on new roads should be as easy as possible.

(3) The radii of curves, where possible, should give an unobstructive view.

(4) Street railway tracks should be placed in the centre of roads and space left on either side for separate tracks for vehicles going in opposite directions.

(5) Main traffic roads should be designed so that tracks be provided for street cars, fast and slow traffic and standing vehicles.

(6) In fixing building lines on what may ultimately become main roads, regard should be paid to future requirements.

(7) The planning of main road communication between towns should be undertaken and some initiative should rest with a central state authority.

Causes of Wear and Deterioration of Roads.—(1) Weather has the most powerful influence on the deterioration of roads. This can be minimized by effective waterproofing.

(2) The damage of heavy motor vehicles is principally caused by the balance, the ratio between propelling power and weight, weight of unsprung portions, continuity of brake action, system of springing, type of tire, diameter of wheel, width of rim, variation of speed and other factors.

(3) Heavy motor vehicles should have wheels of large diameter, with tires of a width adapted to the axle load.

(4) Light motor traffic does not cause damage to roads bound with tar or bituminous materials.

(5) In horse-drawn vehicles diameter of wheel, width of rim, and system of shoeing horses should be considered.

Finance of Construction and Upkeep of Roads.—(1) The upkeep and improvement of all main roads should be paid out of national revenues, whether or not such roads are locally administered.

(2) All tolls on roads should be abolished, but certain vehicles, on account of weight or combined weight and speed, which cause special damage to roads, should be subject to special taxation, the proceeds to go for the construction and upkeep of roads.

Experiments have proved that the binding material on roads under heavy traffic must be of a bituminous or asphaltic nature, prepared tar not standing heavy traffic. Pavements having curb and gutter on both sides give considerable support, prevent lateral thrust and enable better initial consolidation. It is advisable that all improved road crusts should be supported by a sufficient foundation, as the tendency is that the weight, speed and intensity of traffic will increase on roads. On all bituminous or tarry surfaces it is absolutely necessary to carry out repairs whenever the necessity arises, as in the case of water-bound macadam.

Instruction in Use of Tar, Bitumen and Asphalt.—

(1) The stones must be dry and heated.

(2) Top crust never to be laid on damp foundation, and the work should be carried out in dry weather.

(3) Only a sufficient quantity of binder to be used.

(4) Tar not to be overheated; if so, has tendency to cause weakness.

(5) Heating and mixing of stones and tar to be carried out on the work; this the author considers to be a very essential point.

(6) Heavy road rollers should never be used, 3 to 5-ton rollers being preferred.

PRESENT POSITION OF THE SEWAGE DISPOSAL PROBLEM.*

By Gilbert J. Fowler, D.Sc., F.I.C.

IN 1898 the Royal Commission of Great Britain was appointed to inquire and report on the whole question of the treatment and disposal of sewage. The present Royal Commission submitted its first interim report in 1901, and its eighth report, embodying final conclusions on some of the main issues involved, was published in 1912.

In the report of 1901 the commission state that, in their opinion, it is practicable to produce by artificial processes alone effluents which will not putrefy, and which might be discharged into a stream without fear of nuisance. A great part of the Royal Commission's work has consisted in the collection of evidence and the conduct of experiments, with the object of working out the conditions of efficiency of these various processes, and of standardizing the methods employed as far as practicable, so that an authority may have a fair idea what sort of a result is likely to be obtained for a given expenditure.

The fifth report of the Royal Commission and its appendices are a mine of information in this respect, and the appointment of the commission would have been more than justified by this report alone, introducing as it does the idea of quantitative accuracy into the operations of sewage disposal.

There is no excuse now for authorities to launch out on expensive works without any preliminary study as to the character and amount of the sewage to be treated. The commission show clearly that the design and extent of the works must depend on the concentration or "strength" of the sewage. This is roughly proportionate to the water supply per head, and the amount of subsoil drainage finding its way into the sewage system. The composition of the sewage is also affected, e.g., by the quantity and character of the trade effluents discharged into the sewers, and by the proportion of water-closets to pail-closets in the district sewered, and by other factors.

In the fifth report the commission indicate in general terms the kind of works necessary to obtain a satisfactory effluent from sewage of a given character.

This, of course, does not mean that in future all that a corporation or council has to do is to take a sample or two of the sewage, have it classified as strong, medium, or weak, and order a sewage works accordingly.

The chemical and engineering conditions are in no two places alike, and in order to obtain the maximum efficiency and economy under any given set of conditions, careful thought and study on the part of the engineer and bio-chemist will always be necessary.

The author has, e.g., on more than one occasion, recently found that the sewage to be dealt with in small installations in the country is rendered much more offensive and difficult to treat by the drainings from manure heaps which are allowed to enter the sewers. A creamery in a country district may also introduce unforeseen difficulties.

Dry-Weather Flow.—The question of what really constitutes the dry-weather flow is one of great importance and some difficulty. The actual water consumption may vary from 100 to 150 gallons per head, as in New York, to, say, 10 gallons per head or less in a country town or village.

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*Extracts from a paper read before the Liverpool Engineering Society on March 4th, 1914.

It does not quite dispose of the question to say that the strength varies in inverse proportion to volume, and therefore the provision of tanks and filters must be the same for all strengths, the rate of operation alone varying.

Obviously, as regards capacity of sewers the actual quantity to be dealt with must be considered, especially in reference to storm water. While it might be quite reasonable to construct sewers to take six times, say 30 gallons per head, the problem becomes enormous if 100 gallons per head is to be taken as what may be called unit flow. On the other hand, if the dry-weather flow is, say, 10 gallons per head strength, storm overflows set at six times the dry-weather flow would discharge at only twice the dilution of ordinary 30 gallons sewage.

The question of actual quantity, apart from strength, also has to be considered in the design of disposal works. Tanks, channels and distributing mains, have all to be larger if six times an originally dilute sewage has to be dealt with than if the original sewage is strong. There is also the physical limit of speed within which filters can be operated without water-logging. This question of what is to be taken as the dry-weather flow is, therefore of great importance in calculating the sizes and sort of works necessary to deal with a given sewage.

It is because so few towns give returns of what has actually been thoroughly dealt with at their works as compared with the total quantity received, and the cost of such treatment, that it is so difficult to make just comparisons between one method of treatment and another, or one town and another. It is comparatively easy to get constantly good results when filters are carefully nursed, the test comes when they are called upon to take the day-to-day fluctuations year in, year out.

It is to be hoped that reports giving full data of costs in reference to flow and population will be more frequently published in future by municipal authorities than is now the case. Their value cannot be overestimated.

Cost of Effective Treatment.—From such figures as are available, it may be roughly assumed that the total revenue and capital cost for the production of a good effluent will amount to at least 2s. 6d. per head per annum. For small towns it may be more.

The term "satisfactory effluent" has been used in this paper so far without precise definition. This definition has been given by the Royal Commission in their eighth report as follows:—

"An effluent in order to comply with the general standard must not contain as discharged more than 3 parts per 100,000 of suspended matter, and with its suspended matters included must not take up at 65 deg. Fahr. (18.3 deg. Cent.) more than 2.0 parts per 100,000 of discharged oxygen in five days."

Under certain circumstances they indicate that an even more stringent standard may be called for. Few will deny that if every inland town produced an effluent of the character defined above year in, year out, the condition of rivers, especially in the North of England, would be very different. It can be done at a price, and is done, the author believes by certain towns in the potteries and in the Midlands. The more reason that full statistics should be published for the encouragement of others.

Effect of Dilution.—Where the effluent is considerably diluted by the body of water into which it flows, the commission conclude that the standard may, under proper supervision, be relaxed or suspended altogether.

It is however, by no means easy accurately to judge of the effect of dilution. The problem is in the first place one of efficient mixing. Cases will readily be called to mind where sea-outfalls can become a source of serious nuisance if not carefully chosen. Bombay is an example where, owing to a clerical error, the tidal currents were wrongly marked on a map, the outfall site chosen in consequence has proved far from satisfactory, as the sewage lies in a still pool under Malabar Hill, one of the best residential quarters of Bombay.

Other Problems.—It has been shown that it is possible to dispose of sewage without causing offensive pollution in the body of water into which it is discharged. The outstanding problem remaining is the utilization of the sewage. This has been the dream of the sewage enthusiast ever since modern ways of living forced most people away from the simplicities and economies of the Chinaman. The city of Shanghai makes a handsome profit from the sale of night soil, and the water carriage system is unlikely to be installed there, at any rate in the immediate future, if ever.

With its greater convenience and cleanliness the water carriage system entails constant wastage of valuable fertilizing agents which should come back into the cycle of Nature. That they eventually do so to some extent as fish may be granted, but the world needs wheat, and the fact that the Manchester sewage works and others have been able to sell dried sewage manure at a profit in Canada, that Bradford has concluded a contract for its dried sludge with the intensive gardeners of Northern France, indicates that there is an almost unlimited outlook for properly prepared sewage manure, either alone or as a basis for enrichment by artificial fertilizers. This is the conclusion of Dr. H. Maclean Wilson in a recent report, and the author is quite in agreement with him.

In their conclusions as to the value of sewage sludge the Royal Commission do not appear very convincing. They seem to have insufficiently differentiated between sludges of different origin and composition, and it will be of interest to consider the possibilities of each of these in turn:—

Taking first sludge from sedimentation and chemical precipitation processes, which are very similar in character. The most successful utilization of sludge is carried on at Bradford, Yorks, where the whole sewage, containing as it does, a high percentage of grease from woolwashing, is treated and "cracked" with sulphuric acid, the resulting sludge hot pressed, the grease thus recovered sold at a profit, and the residual cake sent away, as has been said, to France.

At Oldham, Dr. Grossman finds a ready sale for the residue left after distilling away the grease from the sludge. It is largely the presence of soap and fat in sludge which precludes its use as manure, as if they are present it will not readily incorporate with the soil. Ordinary pressed sludge cake also contains seeds of weeds and undesirable plants. Thus, if the grease and these seeds are eliminated, a much more satisfactory product is obtained.

Other kinds of sludge than those referred to above are produced in modern sewage works either by anaërobic or aërobic processes.

The latest development of the anaërobic process is the Emscher tank, the first one of which in this country is now being erected at the Withington works of the Manchester Corporation. The Emscher tank consists of two parts, a settling chamber and a sludge digesting

chamber. The sewage passes through the settling chamber, and the sedimentary matters (other than heavy grit, which must first be removed) fall through a slot in the sludge-digesting chamber, which is much larger than the settling chamber. Here the sludge remains and undergoes thorough fermentation, after which it can be run out, and, owing to the peculiar granular nature which it acquires by fermentation, can be readily dried in properly constructed draining beds. The residue thus obtained is quite inoffensive, and is useful itself as a light manure, and can easily be enriched.

In Dublin a process of fermentation of sludge by addition of yeast is in operation. A considerable separation of water occurs in the process, and the fermented and concentrated sludge is dried in an ingenious manner, and the resultant powder sold by itself for 50s. per ton and more, in proportion to added artificial fertilizers.

The mode of action of the yeast is not properly understood, but it has been suggested as the result of experiment that the yeast breaks down and the cellulose cuticle of the yeast ferments somewhat, yielding hydrogen and other gases which cause the solid matters to rise to the top of the fermentation tank, with separation of a considerable percentage of water.

Fermentation of sludge may also be aërobic, and this takes place in the Dibdin slate filter and the ordinary contact bed or percolating filter. The residuum in a Dibden slate bed has to be washed out from time to time, the filtering medium in a contact bed is taken out from time to time, and the humus from a percolating filter is generally caught in so-called humus tanks. These various products, though probably different in many ways, especially biologically, are at any rate generally free from grease, and are granular and inoffensive in character. They are therefore more readily dried than ordinary tank sludge, and in Manchester it is the "slurry," so-called from the washing of the contact beds, which is being dried, powdered and sold at a price which covers cost.

It will be seen that the function of the filter-bed, whether slate bed, contact bed, or percolating filter, is largely the collection and granulation of the colloidal matters in the sewage or tank effluent.

In an address given in November, 1911, as chairman of the Manchester section of the Society of Chemical Industry, the author made the following among other concluding observations:—

"I cannot forbear to mention also a most illuminating suggestion made to me by Dr. Maclean Wilson, that it might be possible to discover some kind of clotting enzyme, which should do the work which now apparently takes place in the surfaces of the medium of the filter-bed. If this could be done, there is a possibility of enormous saving in costly works." While considering the problem of New York, this question was anew forced on the author's attention. The idea, as an alternative to the scheme of sea-disposal already mentioned, of treating some 1,000,000,000 gallons of sewage daily on percolating filters appeared altogether impracticable in view of the possible nuisance from flies and odors. Chemical treatment of such volumes had also its special difficulties.

But experiments on various systems of forced aëration, and collection of the oxidized solids on surfaces seemed to offer possibilities, according to the experiments of Major Black and Prof. Phelps. At the Lawrence Experimental Station the author saw sewage in a bottle which under certain conditions had been completely purified by nineteen hours' aëration. This work is referred to in the recent annual report of the Massachusetts Board of Health. But the element of surface and consequent cost remained.

Since then it has been possible in the author's laboratory at the Manchester University to go further. The author's assistant, Mr. E. M. Mumford, discovered a bacillus in the water of the old colliery workings at Worsley which has the property of precipitating iron from solution in presence of organic matter. It was then found, as already reported at the congress of the Royal Sanitary Institute at Exeter, that if this organism is added to sewage effluent, together with a little iron salt, and air is blown through, complete clarification results, and the resulting deposit has a very high nitrogen content. Since then the engineering developments of the process have been the chief concern, but it has been possible successfully to inoculate about 5,000 gallons of sewage with a pure culture of the organism, and a plant is now being experimented with capable of dealing with 10,000 gallons per day.

Laboratory experiments are in progress at Davyhulme which indicate even more far-reaching possibilities, and the author looks forward with confidence to the time when it will be possible completely to purify sewage in a tank with production on the one hand of inoffensive sludge, which can be readily handled and disposed of as manure, and of the other on a well aërated effluent, in which aquatic plants and fish will make final use of the nitrogen and phosphates in solution. The problem in its present stage is largely one of engineering, but granted the possibility of applying large quantities of air economically to sewage, the saving in space and capital cost may be very great.

It should be practicable even for seaport towns to purify their sewage without great difficulty before discharge, retaining the insoluble matters in an inoffensive form, easily disposed of as fertilizer. A sewage works will then no longer be a source of nuisance and trouble, either from decomposing offensive sludge, or from flies and odors from percolating filters.

Need for Research.—In conclusion, it is necessary to emphasize again that real advance in the art and practice of sewage disposal must come through the avenue of scientific research of the highest order. It is well to remember that the modern developments are only the practical application of principles discovered long since by men like Pasteur, Warington, Frankland, and many others, without whose work sewage disposal would be mere empiricism.

Such research work necessitates well-equipped laboratories and large staffs of highly trained workers. The author realizes the responsibility in having at his disposal the resources of the Manchester University and the Manchester Corporation for this purpose, but the work is a national one, and it is to be hoped that the present Royal Commission will not be concluded before its work has been put on a permanent footing in the establishment of a national research department which could carry out work of a wider scope than is possible for any one local authority, and could correlate the work done by such authorities to the general benefit of all.

In what has been said the author is not for a moment forgetting that for the practical application of the discoveries of the bio-chemist the close co-operation of the engineer is necessary. It is through this harmonious working together of two great professions that advances may be looked for in the future adequate to the demands of complex modern life.

THE EUGENIA FALLS POWER INVESTIGATION.

In the annual report for the year ending October 31st, 1913, of the Hydro-Electric Power Commission of Ontario, the progress which the engineers of the Commission have made on a scheme for the supply of electric power to Owen Sound, Ont., and surrounding district has been described.

In the 1911 report of the Commission it was stated that the best local source of hydro-electric energy for this district was Eugenia Falls on the Beaver River, and owned by the Georgian Bay Power Company, and a report was prepared based on such data as was then available, demonstrating the value of this source of power. This report indicated that the site had a commercial capacity of about 2,000 h.p. under natural conditions, and about 4,000 h.p. if the total run-off of the watershed could be artificially controlled.

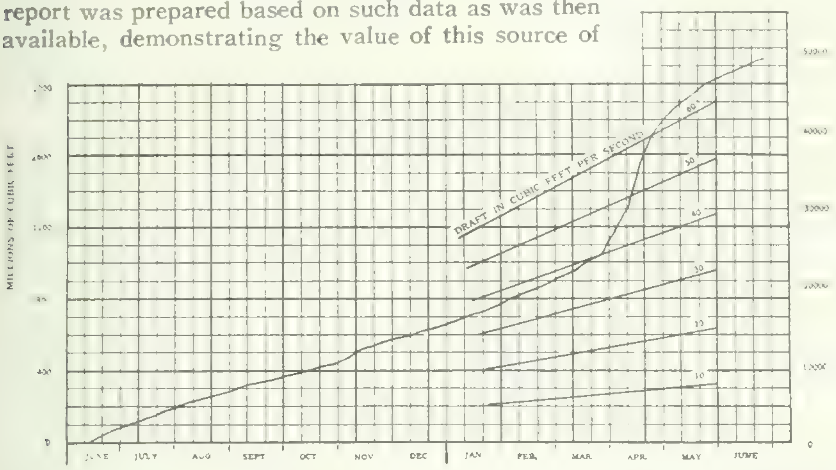

Fig. 1.—Mass Curve, Beaver River, June, 1910, to June, 1911, Inclusive.

Data on River Flow.—With respect to the hydrology of the Beaver River, the present report contains some very interesting data, derived from weir records of the river flow at Eugenia.

To compute the amount of yield of the watershed from the series of daily gaugings for the year ending June 30th, 1911, and to determine the volume of reservoir storage required to store the flood waters in order that any constant rate of flow may be maintained, the mass curve method has been used. Fig. 1 shows the curve obtained.

This method consists of totalling the daily discharges of the watershed from day to day for the whole period, which quantities are then plotted as an irregular line, or "mass curve." Any desired rate of draft may then be assumed, and the amounts necessary at different times plotted to the same scale. If a uniform rate, this draft curve forms a straight inclined line, and if it is made to start coincident with some point or summit on the "mass curve," the ordinate between the two curves at any point serves to show the volume of storage that would be required at this date to have maintained the required rate of draft up to that time. (For further explanation of the mass curve in determining stream flow yield the reader is referred to *The Canadian Engineer* for June 6th, 1913, page 819.)

The mass curve, plotted as above outlined, for the period of June, 1910-June, 1911, gives the reservoir capacities necessary to insure certain uniform rates of flow, beginning with 23 cu. ft. per sec., the minimum flow for the year. These rates of draft, with the required reservoir capacities obtained from the mass curve, are shown in the diagram of required capacity of reservoir for varying rates of draft, Fig. 2. This diagram shows that to secure a uniform flow equal to the mean annual flow (or 65 cu. ft. per sec.), it will be necessary to provide a reservoir capacity of 600 million cu. ft., or about 14,000 ac.-ft. To secure 50 cu. ft. per sec., 245 million cu. ft. of storage or about 5,700 ac.-ft. will be required.

The scheme of development at Eugenia, most economically feasible, is one involving the building of a dam above Eugenia Falls, a diversion canal from the reservoir thus formed, and about 5,000 feet of pipe line for an effective head of 500 feet. The initial development of 2,000 h.p. can be obtained with a dam 23 feet high. When the load builds up sufficiently to warrant extension of the plant, the water to operate an additional unit of 1,000 h.p. can be secured by raising this dam 10 feet. For the final development or full capacity, additional storage can be secured by a dam at Feversham, about 8 miles above Eugenia.

A study of the curves of storage capacities for different contour elevations that have been plotted for dams at Eugenia Falls and at Feversham, when analyzed in connection with the reservoir-draft curves, gives the necessary height to which the dams must be carried for any required amount of flow. The results are shown in the report, together with curves of storage capacities for different contour elevations for Eugenia which are more or less approximate, and which may be changed when further data are obtained from the surveys now in progress.

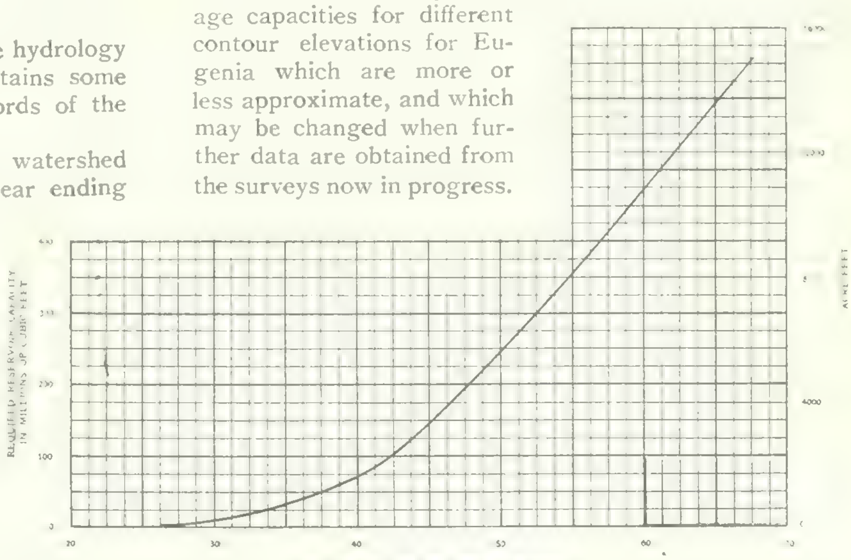

Fig. 2.—Required Reservoir Capacity for Various Rates of Draft, Based on Weir Records, Beaver River, 1910-11.

A reference to the mass-curve (Fig. 1) indicates that the fall replenishment of storage is very limited for this watershed. This conclusion is borne out by the discharges taken during 1913. Thus the storage reservoirs must impound sufficient water during the months of March, April and May to carry over the rest of the year, since it is impossible to depend on a fall filling.

The problem of determining the proper turbine capacity to install at any power-site is a difficult matter,

depending to a great extent on the judgment of the designer. One method of obtaining the economical capacity of a river, to generate power, is by means of a "duration curve." The duration curve is plotted by ranging the several daily discharges in order of their size; i.e., the maximum quantity for any one day in the year is placed as an ordinate over, say, the first day in the year, and so on down to the smallest daily quantity for that year, placed as an ordinate for the three hundred and sixty-fifth or last day of the year. This gives a smooth regular line, as may be seen in Fig. 3, the duration curve plotted for June, 1910, to June, 1911. From this curve the duration during the year of any given river flow may be directly read off.

Experience on rivers used for water power has shown that, in general, the quantity found to obtain at ordinate 182½ on the curve represents the proper and most efficient turbine capacity that may be installed. A variation of 30 days either side of this ordinate is in cases admissible.

The duration curve for 1910 and 1911 represents the flow of a minimum year, as was noted in the 1911 report of the Commission. On the ordinate 182½ the flow is 43 cu. ft. per sec., at 152½ the flow is 48 cu. ft. per sec. It is reasonable to expect that the average flow ordinate at 182½ will be at least 50 cu. ft. per sec., and at 152½ will be 55 cu. ft. per sec. for an ordinary year.

The development will therefore be planned to use the most economic turbine capacity represented by this flow. The ultimate capacity will, of course, be controlled by the later discharge records which will be obtained during the operation of the plant, and which will give more data for fixing the average flow to be expected. The operating records of the plant will also give the load factor to be expected on the complete ultimate development.

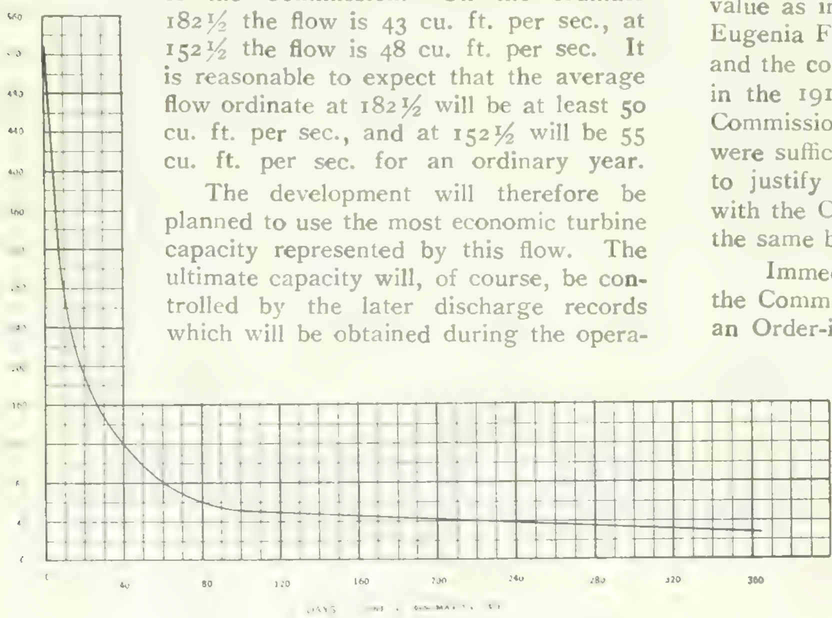

Fig. 3.—Duration Curve, Beaver River.

An inspection of the monthly flow tables for the Beaver River during 1910-11-13, shows a very remarkable coincidence of values for the months of low flow. This is due primarily to the fact that the Beaver River is a spring-fed stream in the fullest sense of the term, ground storage capacity existing to an unusual degree. This condition is in turn influenced by the existence of large tracts of undrained and uncleared swamp throughout the watershed.

Feasibility of the Project.—The success of any scheme of development at Eugenia Falls was dependent, to a large extent, upon the amount of power which could be used in Owen Sound, and upon the willingness of the municipality to enter into a contract for the supply of same. The town took no definite action in connection with the matter until early in 1913, when the light and power commissioners of Owen Sound opened negotiations with the Commission, with a view to ascertaining under what conditions they could obtain a supply of power, having special reference to the possibility of obtaining it from Eugenia Falls. After considerable discussion it was finally agreed that the town of Owen Sound would enter into a contract with the Commission, if it could be proved to the satisfaction of the municipality that Eugenia Falls was capable of supplying the necessary quantity of power. In this connection, the light and power commissioners asked for further confirmation of the data submitted in the report of 1911. While the Commission was satisfied to base its findings upon the 1911 report, it was nevertheless decided to accede to the request of the municipality, and to this end a sharp-crested weir was built at Eugenia Falls, and a recorder employed for the purpose of making continuous measurements of flow, as mentioned above. The light and power commissioners wished particularly to be assured that the records of low water flow, as set forth in the report of 1911, be confirmed, and it so happened that the summer of 1913 was one of the driest on record in that district, so that the results of the 1913 measurements are of great value as indicating the low water power capacity of the Eugenia Falls site. The details of the 1913 investigation and the comparison of the same with the results set forth in the 1911 report indicate that the contentions of the Commission's engineers were sustained, and the results were sufficiently satisfactory to the town of Owen Sound to justify the municipality in entering into a contract with the Commission for the initial supply of 1,200 h.p., the same being executed under date of October 27, 1913.

Immediately following the execution of the contract, the Commission made application to the Government for an Order-in-Council authorizing the Commission to purchase the works, assets, real property and rights of the Georgian Bay Power Company, together with such additional rights as might be necessary, and to develop power at Eugenia Falls and distribute same to the various municipalities in the Owen Sound district. The required Order-in-Council having been issued, the work of making a final survey of the site was commenced immediately and preparations made to proceed with the design of the plant. This work is in progress.

In connection with this development, it may be mentioned that the projected scheme calls for an operating head of 500 feet. With the exception of one or two plants in British Columbia, this will be the highest head in existence in Canada.

The American Institute of Electrical Engineers has authorized the formation of a Panama section There are some 30 members of the Institute now on the Isthmus.

The first railway in Iceland will be under construction in the near future. Plans have been completed, and it is not doubted that these will be accepted by the Althing, or the national assembly of Iceland. The new Icelandic railway will be a narrow gauge line running from Reykjavik through the Thingvalla district - the most fertile part of the island—to Rangavalle, a distance of about 64 miles, with a branch line to the port of Eyrarbakki, an additional 12 miles. Although the track will run through hilly country, the boring of tunnels will be avoided; but a great many bridges are necessary to carry the line across numerous streams. These bridges have to be of especially solid construction, owing to the floods which come down in raging torrents from the mountain sides in the brief Icelandic summer.

AMERICAN ROAD BUILDERS' ASSOCIATION.

At a meeting of the Board of Directors of this association, in New York City, February 24, it was decided to hold the eleventh annual convention and exhibition at Chicago in December, 1914.

The detail for arranging the meeting and exhibition will be in the hands of the Executive Committee, which was re-elected at the last meeting and consists of George W. Tillson, E. L. Powers and R. A. Meeker.

James H. MacDonald, former State Highway Commissioner of Connecticut, was elected a director to fill out the unexpired term of Chief Engineer A. W. Dean, of the Massachusetts Highway Commission, who was elected second vice-president at the annual election of officers last month.

CANADIAN PAVING IN 1913.

THE figures in the accompanying table convey an idea of the activities of Canadian cities during the past year in the matter of street pavements. Last year *The Canadian Engineer* published a general summary on the extent and wear of Canadian pavements, classifying the data collected from civic officials and outlining their opinions, as derived from their observations and experience, of the various types that had been laid under varying traffic, climatic conditions, construction, etc. The reader is referred to our issue of September 25th, 1913, for this information, including the mileages of pavements that were laid prior to 1913.

Of course, the financial stringency which enveloped municipal activities in 1913 is reflected somewhat in the extent to which paving work was carried on. Among the cities reporting upon the season's work, Cranbrook, B.C.; Lethbridge, Alta.; Medicine Hat, Alta.; Moncton, N.B.; Portage la Prairie, Man.; Prince Albert, Sask.; Prince Rupert, B.C.; Revelstoke, B.C.; Rossland, B.C.; St. Hyacinthe, P.Q.; Sydney, N.S., and Trail, B.C., report no permanent paving at all, and are, therefore, withdrawn from their respective places in the table. The statement that they did no paving should be modified slightly, however. In Moncton, N.B., the streets were subjected to considerable opening during the season owing to the laying of natural gas and water mains. All that has been done in Prince Rupert, B.C., in the matter of street work has been a rough grading with a covering of about 3 inches of broken stone, unrolled. All its sidewalks and outlying streets are paved with wood plank. Prince Albert, Sask., and Revelstoke, B.C., have no pavements of any kind. The only work done in Sydney, N.S., was in the nature of repairs. Trail, B.C., carried on operations to the extent of laying about 1,050 square yards of wood plank.

Among the cities included in the table it will be noticed that a few have shown a very small increase for the year. For instance, the extent of paving in Moose Jaw for 1913 consisted of 5,000 square yards of vitrified brick in a subway under railway tracks. It might be mentioned that a very satisfactory pavement was obtained by careful grading, a 5-inch concrete foundation, sand cushion, and the use of 1:1 cement grout. Its cost was $3.53 per square yard.

Reflecting upon the monetary situation, the small showing of some cities in the matter of improvements was naturally to be expected. It should be stated, however, that the extent of paving done is no criterion of the status of the municipality in the eye of the investing public. It is not the desire of *The Canadian Engineer* to show up any lack of activities in paving or to reflect in any way to the difficulties which some cities experienced in selling municipal bonds. Other lines of municipal work were, in some cities, much more needed than paving and asserted their plea for immediate consideration. Again, the indefiniteness of the duration of lull in financial activities prompted economy in the matter of civic expenditure. These and other factors, all of whch have been dwelt upon from every conceivable viewpoint during the past year, brought about a condition in pavement work throughout the Dominion in 1913 that is well illustrated in the returns published herewith.

There are many interesting points to be noted in 1913 paving returns, some of them indicating a decided trend towards uniformity throughout the country, in the matter of general construction, bonding of contract work, withholding of percentage of contract, etc.

Macadam and gravel roads have been included in the list as they form the wearing surface on over half of the paved streets of the cities of Canada and United States, predominating on pleasure drives, in parks and purely residential districts. Eliminating gravel and water-bound macadam from the total, it is found that 93% of the three million square yards has been laid on a concrete foundation of thickness varying from 4 to 6 inches. The adoption to this extent of concrete for foundation work shows its general acceptance in the majority of our cities.

Winnipeg is the only city to report the laying of untreated wood block during the year. Using two 1-inch boards under it, 2,285.35 square yards were laid by city day labor.

More uniformity shows itself in the term of years through which a pavement is bonded, than had been noted in previous years. St. John, N.B., requires a 20-year bond. Guelph, London, Ottawa, Toronto and Windsor stipulate 10 years. Of the remainder, twenty cities require only 5 years. In the case of London, on a 10-year guarantee a bond is taken over 5 years from a guarantee company for 50% of the amount of the contract together with the contractor's bond over 10 years with a 6% retention. Montreal bonded its stone and wood block for one year only. Quebec bonded its stone and Scoria block for two years. St. Catharines made it three years in the case of Rocmac, used on hilly approaches to the city and on residential streets with grades. Toronto bonded its Rocmac and Dolorway for three years. Vancouver bonded its creosoted wood block for one year by the contractors and required a 10-year guarantee from the manufacturers of the blocks. Winnipeg had some 4,800 sq. yds. of concrete pavement laid by contract without bond, and Woodstock laid a small amount under the same conditions.

In their contract work Edmonton, Guelph, Montreal, New Westminster, Ottawa, Quebec, Regina and St. Boniface withheld 10% of the amount of contract. St. John, Saskatoon, Stratford, and Windsor kept back 5%. Toronto withheld 15%; St. Catharines withheld 33% on asphaltic concrete and 35% on Rocmac work. Westmount had 20% of the amount of its sheet asphalt contracts covered by bond by the contractor, put up for 5 years. In Westmount during the progress of the asphalt work, progress certificates are issued monthly to the amount of 80% of the work completed, a final payment of the whole amount of the contract being made immediately after the completion of the work.

Extent of Paving in Canadian Cities during 1913

City*	Asphalt Block	Bitulithic	Brick	Concrete (Plain or Tarred)	Gravel	Macadam (Asphalt or Tar)	Sheet Asphalt	Stone Block	Wood Block (Untreated)	Wood Block (Treated)	Water Bound Macadam	Asphaltic Concrete	Total in Sq. Yds.
Belleville, Ont.					12,000	15,000							27,000
Brandon, Man.	16,539					14,000							30,539
Brantford, Ont.					23,000	8,000					13,000	7,000	51,000
Charlottetown, P.E.I.											2,166		2,166
Chatham, Ont.				6,000									6,000
Calgary, Alta.		41,650						9,721				171,497.9	222,868.9
Edmonton, Alta.		116,351.6					82,579.4					115,738.9	314,669.9
Fort William, Ont.					32,408	4,816							37,224
Guelph, Ont.				3,500		6,500							10,000
Halifax, N.S.		15,000						470					15,470
Hamilton, Ont.			3,540				134,876	1,541		43,473	65,000	31,067	279,497
Hull, P.Q.												10,000	10,000
Kingston, Ont.	12,486					9,675							22,161
London, Ont.			799	5,482	30,690		13,998						50,969
Montreal, P.Q.		40,053	2,811			71,166	267,368	136,816		2,047			520,261
Moose Jaw, Sask.			5,000										5,000
Nelson, B.C.					1,000						2,180		3,180
North Vancouver, B.C.											81,000		81,000
Ottawa, Ont.						6,027	81,721	2,409		2,640			92,797
Peterborough, Ont.			318		18,500							8,400	27,218
Port Arthur, Ont.						3,552					61,405		64,957
Quebec, P.Q.	4,513.66						51,699.69	28,702.06					84,915.41
Regina, Sask.		82,874.8					60,992.6	1,287				421.1	145,575.5
St. Boniface, Man.		27,800		2,380									30,180
St. Catharines, Ont.		27,634	2,600			18,004						23,509	71,747
St. John, N.B.		10,686	478	586		4,703		2,590				6,800	25,843
Saskatoon, Sask.		27,085					18,947	7,307		6,085			59,424
Sherbrooke, P.Q.											10,000		10,000
Stratford, Ont.			3,911			10,396					6,450	3,119	23,876
Toronto, Ont.	2,986	65,083	26,432	23,855		68,065	378,466	8,188		25,783		5,418	604,276
Vancouver, B.C.		6,255	4,847	302				9,071		10,587		26,474	57,536
Victoria, B.C.				26,366			52,411						78,777
New Westminster, B.C.		40,854	5,955							1,418		5,890	54,117
Westmount, P.Q.						13,225	16,293				32,097		61,615
Windsor, Ont.	16,410			96,269									112,679
Winnipeg, Man.				16,412.44		15,143.08	112,139.68		2,285.35		1,205.43		147,185.98
Woodstock, Ont.				1,230							10,600		11,830
Total in sq. yds. (38 cities)	52,934.66	501,326.4	56,691	182,382.44	117,598	268,272.08	1,271,491.37	208,102.06	2,285.35	92,033	285,103.43	415,344.9	3,453,554.69

*Cities reporting no paving in 1913, and therefore not included in the above: Cranbrook, B.C.; Lethbridge, Alta.; Medicine Hat, Alta.; Moncton, N.B.; Portage la Prairie, Man.; Prince Albert, Sask.; Prince Rupert, B.C.; Revelstoke, B.C.; Rossland, B.C.; St. Hyacinthe, Que; Sydney, N.S.; and Trail, B.C.

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CONTENTS OF THIS ISSUE.

A MOVEMENT AMONG ENGINEERS FOR BETTER PUBLIC SERVICE.

Engineers who have at heart an altruistic desire for the betterment of public service will find it very encouraging to review the work during 1913 of the American Institute of Consulting Engineers. With a membership of 70, the majority of whom reside in New York State, and six of whom, it may be added, reside in Canada, the Institute is doing the country, and the profession as well, a great deal of good.

Perhaps no better examples of the justification of its existence can be presented than those outlined in a brief review of its 1913 activities. From time to time committees were appointed from its membership to urge the appointment of engineers as members of commissions and as heads of departments of public service having to do with engineering matters. The opening arguments of these committees are, in themselves, quite characteristic of the motives of the Institute.

In January, 1913, a presentation was made to the Governor of New York State for the appointment of engineers on public service commissions, which began: "We have no personal or individual ambitions to serve and no candidates to present, but as citizens, however, and expressing the sentiment of a body of professional men who, more than any other understand the problems involved in the execution and management of great public works, we may be permitted an altruistic viewpoint and speak for what we believe to be the best interests of the city and State."

In April, a communication to the Interstate Commerce Commission, recommending the creation of an advisory board of engineers in connection with the valuation of railroads, maintained the same viewpoint, as follows:

"It is perhaps not understood by the general public that the results of this great work will be of vital import to all classes of citizens, investors and non-investors alike, and that the general well being of a vast community is indissolubly bound up with the outcome."

Similar purposes were expressed on another occasion in advocating the organization of an engineering commission to act with the consulting architect of New York. And, later, in urging the appointment of engineers on public service commissions of the state, expression of the views of the Institute of the standard to which these appointments should conform was given as follows:

"In thus urging the appointment of engineers on the public service commissions, we recognize that their selection should not be based on their technical attainments alone, but also on the same degree of business and administrative acumen that should be possessed by appointees from other walks of life." Again, "That high character, tact and business and administrative ability are absolutely necessary qualifications for anyone competent to fill these positions, and we believe that these departments cannot be administered with the efficiency and economy that you desire unless they are under the leadership of such types of engineers."

In a communication to the President of the United States, advocating the appointment of an engineer on the Interstate Commerce Commission, it was observed: "The Institute has no candidate to present for office and is therefore enabled to address you from an impartial stand-

point, free from personal ambitions and solely in behalf of the public interests."

This brief summary of the aims and activities of the organization, recalls our need in Canada for the performance of a similar duty to the public. It may often be disagreeable, and sometimes misinterpreted, as there is at times the semblance of a pronounced unbelief that any act of man can be unselfish. But, every province and every city has instances of its own as evidence of the fact that sound engineering knowledge and ability is not always called into service when it should be. The public at large is unaware of the existence of this strength. It is common knowledge only among those in direct touch with efficient engineering service. It is the duty of engineers themselves to advocate its inception into public affairs, in the face of injustifiable criticism of selfish motives, and the blowing of trumpets. The American Institute of Consulting Engineers has attacked the problem in a manner that is safe and sane and certain to bear creditable fruit.

EDITORIAL COMMENT.

Previous to its deliverance on April 7th, the budget speech of the Minister of Finance at Ottawa maintained live interest in the Canadian iron and steel market—interest that remained curiosity with some had engendered anxiety on the part of others, the latter being chiefly those associated with the iron and steel industry from a manufacturer's point of view. It was not generally expected that the Government would extend further assistance, except a possible revision in the nature of protection to wire rods, for which several important corporations had so long and vigorously contended.

As noted in next column, wire rods received a duty of $3.50 per ton under the general tariff and $2.25 under the British preferential. As but a small proportion is brought in from England, the industry will practically get the advantage of the $3.50 tariff.

The Dominion Iron and Steel Corporation and the Steel Company of Canada are the chief companies affected by this change. Managers of both companies have expressed themselves pleased with the new duty.

As for the structural steel industry, also affected by new duties, it is not easy to acquire a general opinion at such an early date. Some structural men have discussed the tariff and the effect it will probably have on the cost of building, which, they claim, is already too high.

* * * *

Mr. Geo. A. Janin, City Engineer of Montreal, recommends the appointment of a board of technically trained engineers to assist in the execution of duties pertaining to the various departments under his direction. It is stated that he also advises that a deputy chief engineer be appointed.

The department of roads, bridges and tunnels is temporarily in the charge of Mr. J. H. Dubuc, by appointment of the late Board of Control. Mr. G. R. Macleod is in charge of railways, while for the third department, that of sewers, waterworks and municipal buildings, no member of the board has yet been appointed. One of the first duties of the new board of control will be to consider the appointment of this complete staff.

CHANGES IN THE TARIFF SCHEDULE.

THE changes effected by the new tariff schedule submitted by the Minister of Finance in his budget speech to the House of Commons on April 6th, comprise a number of items of interest to readers of *The Canadian Engineer.*

The following items have a direct bearing upon engineering construction, particularly in the case of the iron and steel industry:

Rolled iron or steel angles, beams, channels and other rolled shapes and sections of iron or steel not punched or drilled or otherwise further manufactured, weighing over 120 pds. per lineal yd., not otherwise provided, not square, flat, oval or round shapes, and not being railway bars or rails, changed from $2, $2.75 and $3 to $2, $3 and $3 per ton under British preference, intermediate and general tariffs, respectively.

Galvanized hoopsteel changed from 30% to $7 per ton, general tariff.

Wrought or seamless iron or steel tubing, from 4 to 10 in. diam., changed from 10, 12½ and 15% to 20, 30 and 30%.

Wrought or seamless iron or steel tubing over 10 in. in diam., changed from 10, 12½ and 15% to 10, 15 and 15%.

Coil chain and links 1¼ in. in diam. and over, changed from 5, 7½ and 10% to free, 5 and 5%.

Coil chain and links under 1⅛ in., changed from 5, 7½ and 10% to 15, 20 and 20%.

Malleable sprocket chain or link belting chain made free when used in agricultural implements, whereas it was formerly free for all purposes.

Rolled round wire rods in the coil of iron or steel, not over ⅜ in. in diam., changed from free to $2.25, $3.50 and $3.50 per ton, when imported to manufacture wire in the coil; for use in the manufacture of chain changed from free to $2.25, $3.50 and $3.50.

Chloride of lime and hypochlorite of lime, in packages of not less than 25 pds., transferred from the free list and made dutiable at 10c. and 15c. per cwt. When in packages of less than 25 pds., 17½, 25 and 25%, instead of free.

Cork slabs, boards, planks and tiles produced from cork waste or ground cork, changed from 15, 17½ and 20%, to 20, 30 and 30%.

Building stone, sawn on four sides, is made dutiable at 15c. per cwt., and when further manufactured at 45c., instead of 20%, as formerly.

Carbon electrodes of over 35 in. in circumference, changed from 3 to 20%.

Ferrosilicon made $4.50 a ton, instead of $2.50.

Ferro-manganese and spiegeleisen changed from $2.50 a ton to free.

Among the provisions for drawbacks are the following:—

Lapwelded tubing of iron or steel, not less than 4 in. in diam. and used in casing wells or for natural gas transmission, 50%.

Bituminous coal, drawback of 99% of duty extended to coke ovens, other than those owned by smelting works, when intended for smelting and melting ores.

Wire rods used for the manufacture of fencing wire, 9, 12 and 13 gauge, 99% of duty.

Charcoal used for smelting of ores, 99%.

Rolled hexagon iron or steel bars used in the manufacture of cold-drawn or cold-rolled iron or steel bars or turned and polished shafting, 99%.

THE STEEL HARDENING PROCESS.

By R. H. Cunningham, B.A.Sc.,
General Manager, Canadian Hoskins, Limited,
Walkerville, Ont.

ORIGINALLY the name "steel" was applied to various combinations of iron and carbon, there being also present, as impurities, small proportions of silicon and manganese. At the present time, however, the use of the name is extended to cover combinations of iron with tungsten, vanadium, nickel, chromium, molybdenum, titanium and some of the rarer elements. These latter combinations are quite generally known as the "alloy steels" to distinguish them from the "carbon steels," those in which the characteristic properties are dependent upon the presence in the steel of carbon alone. The alloy steels are divided into the "high speed" steels and the Mushet or "air-hardening" steels.

The specific properties that distinguish these different steels are due in part to their respective compositions, i.e., to the particular elements they may contain and the relative proportions in which these occur, and, in part, to their subsequent working and heat treatment.

Effect of Difference in Composition.—In general, any change in the composition of a steel results in some change in its properties. For example, the addition of a certain metallic element to a carbon steel causes, in the alloy steel thus formed, a change in position of the proper hardening temperature point. Tungsten or manganese added, tend to lower this point; boron and vanadium, to raise it. The amount of the change is practically proportional to the amount of the element added.

Further, adding a small proportion of carbon to iron produces steel, which has decidedly different properties than pure iron. Increasing the proportion of carbon in the steel thus formed, within certain limits, causes a variation in the degree in which these properties manifest themselves. For example, consider the property of tensile strength. In a 0.1 carbon steel (one in which there is present but 0.1% of carbon) the tensile strength is very nearly 25% greater than that of pure iron. Adding further carbon causes this to rise, at approximately the rate of a 2.5% increase in tensile strength for each 0.01% of carbon added.

Due alone to differences in proportion of carbon present, carbon steels are divided into three classes. The first of these embraces the "unsaturated" steels, those in which the carbon content is lower than 0.89%; the second, the "saturated" steels, in which the proportion of carbon is exactly 0.89%; and the third, the "supersaturated" steels, those in which the carbon content is higher than 0.89%.

Effect of Heat Treatment.—With a steel of a given composition, proper heat treatments may be applied which of themselves will alter in form or degree some of its specific properties, or practically eliminate one or more of them, or, perhaps, add certain new ones. Physical properties of size, shape and ductility are examples of the first. Of the second, heating a steel beyond its hardening temperature takes away its magnetism, making it "non-magnetic." And the third, the property of hardness—for practical purposes—may be added to a steel by the process of hardening. In connection with this it must be understood that strictly speaking, "hardness" is a relative term and that all steel has some hardness.

There are three general heat treatment operations so considered—forging, hardening and tempering. In all of these the object sought is to change in some manner the existing properties of the steel; in other words, to produce in it certain permanent conditions. Each of these operations, broadly speaking, consists of two parts, viz., raising and lowering the temperature of the piece. (In forging, of course, mechanical work is also done upon it.)

Obviously then, the controlling factor in all heat treatment is temperature. Whether the operation is forging, hardening or tempering, there is, for any certain steel and particular use thereof, a definite temperature point, at which to work the steel, that alone gives the best results. Insufficient temperatures, either through ignorance of what the correct point is, or through inability to tell when it exists, cause "burned" steel. This is a common failing, resulting in great loss. In degree, very slight variations, from the proper point, may do irreparable damage.

Due to temperature variation alone, steel may be had in any of three conditions: (1) in the "unhardened" or annealed state—when not heated to temperatures above 735° C. (1355° F.); (2) in the "hardened" state—by heating to temperatures between 735° C. (1355° F.) and 820° C. (1508° F.); (3) in a state softer than (2), though harder than (1), when heated to temperatures which exceed 820° C. (1508° F.).

The Hardening Process.—Hardening a carbon steel is the process of increasing its degree of hardness, this property being its power to resist penetration. It is the result of a change of internal structure which takes place in the steel when heated properly to a correct temperature. In the different carbon steels this change for practical purposes is effective only in those in which the proportion of carbon is between 0.2% and 2.0%.

When heated, ordinary carbon steels begin to soften at about 200° C. (392° F.) and continue to soften throughout a range of 170° C. At the point 370° C. (698° F.) practically all of the hardness has disappeared. "Red hardness" in a steel, is a property which enables it to remain hard at red heat. In a high-speed steel this property is of the first importance, 550° C. (1022° F.) being a minimum temperature at which softening may begin. This is some 350° C. above the point at which softening commences in ordinary carbon steels.

The process of hardening a steel is best carried out in a closed furnace. Of the many sources of energy capable of producing the required heat, electricity offers the most attractive advantages. The electric resistance furnace, as now built in such a variety of sizes of either muffle or tube chamber types, has one fundamental point of superiority over all coal, coke, gas or oil-heated furnaces. *It is entirely free from all products of combustion*, the heat being produced by electrical resistance. This is important. It does away with the chief cause of oxidation of the heated steel. Further, the temperature of the electric furnace can be easily and accurately regulated to, and maintained uniform at, any desired point. When electric power is generated for other purposes, the increased cost of this form of energy for operating furnaces is not sufficient to orgue against it. Even when current is purchased, the superior quality of work performed by this kind of furnace, frequently more than offsets the slightly higher cost of operation.

In the actual heating of a piece of steel, it is essential to good hardening that small projections or cutting edges are not heated more rapidly than is the body of

the piece, i.e., that all parts are heated at the same rate, and also that all parts are heated to the same temperature. These conditions are facilitated by slow heating, especially in case the treated piece is large. A uniform heat, as slow in temperature as will give the required hardness, produces the best product. Lack of uniformity in heating causes irregular grain, internal strains and may even produce surface cracks. Any temperature above the "critical point" of a steel tends to open its grain—to make it coarse and to diminish its strength, though such a temperature may not be sufficient to lessen appreciably its hardness.

Critical Temperatures.—The temperatures at which take place the previously mentioned internal changes of structure of a steel, are frequently spoken of as the "critical points." These are different in steels of different carbon contents. The higher the percentage of carbon present, the lower the temperature required to produce the internal change. In other words, the critical points of a "high" carbon steel are lower than those of a "low" carbon steel. In steel of the commonly used carbon contents there are two of these "critical temperatures," called the "decalescent point" and "recalescent point" respectively.

The decalescent point of any steel marks the correct hardening temperature of that particular steel. It occurs while the temperature of the steel is rising. The piece is ready to be removed from the source of heat directly after it has been heated uniformly to this temperature, for then the structural change, necessary to produce hardness, has been completed. Heating the piece slightly higher may be desirable for either or both of the two following reasons: (1) In case the piece has been heated too quickly, and not uniformly, this excess temperature will assure the structural change being complete throughout the piece; (2) any slight loss of heat which may take place in transferring the piece from the furnace to the quenching bath may thus be allowed for, leaving the piece at the proper temperature when quenched.

If a piece of steel, which has been heated above its decalescent point be allowed to cool slowly, it will pass through a structural change, reverse to that which takes place on a rising temperature. The point at which this takes place is the "recalescent point" and is lower than the rising critical temperature by some 30° to 100° C. (86° to 212° F.). The location of these points is made evident by the fact that while passing through them the temperature of the steel remains stationary for an appreciable length of time. It is well to observe that the lower of these points does not manifest itself unless the higher one has been first fully passed.

It is for the reason that these critical points are different for different steels, that they cannot be definitely known, for any particular steel, without an actual determination.

Heating a piece of steel to its correct hardening temperature thus produces a change in its structure, which makes possible an increase in its hardness, but this condition is only temporary unless the piece is "quenched."

Quenching.—This treatment consists in plunging the heated steel into a bath, cooling it quickly.

By this operation the structural change seems to be trapped and permanently set. Were it possible to make this cooling instantaneous and uniform throughout the piece, it would be perfectly and symmetrically hardened. This condition can not, however, be realized, as the rate of cooling is affected both by the size and shape of the treated piece; the bulkier the piece, the larger the amount of heat that must be transferred to the surface and there dissipated through the cooling bath; the smaller the exposed surface in comparison with the bulk, the longer will be the time required for cooling. Remembering that the cooling should be as quickly accomplished as possible, the bath should be amply large to dissipate the heat rapidly and uniformly. Too small a quenching bath will cause much loss, due to the resulting irregular and slow cooling. To insure uniformly quenched products the temperature of the bath should be kept constant so that successive pieces immersed in it will be acted upon by the same quenching temperature. Running water is a satisfactory means of producing this condition.

The composition of the quenching bath may vary for different purposes; water, oil or brine being used. Greater hardness is obtained from quenching, at the same temperature, in salt brine and less in oil than is obtained by quenching in water. This is due to a difference in heat-dissipating power possessed by these substances. Quenching thin and complicated pieces in salt brine is unsafe as there is danger of the piece cracking, due to the extreme suddenness of cooling thus produced.

In the actual round of shop work the steel to be hardened is generally of a variety of sizes, shapes and even compositions. To obtain uniformity both of heating and of cooling, as well as the correct limiting temperature, the peculiarities of each piece must be given consideration in accordance with the above outlined points. In other words, to harden all pieces in a manner best adapted to but one, would result in inferior quality and possible loss of all except this one. Each different piece must be treated individually in a way calculated to bring out the best results from it.

Theory.—The presence of these critical points in the heating and cooling of a piece of steel is a phenomenon. The most reasonable theory advanced to explain this is as follows:—

While heating, the steel uniformly takes on heat. Up to the decalescent point all of the energy of this heat is exerted in raising the temperature of the piece. At this point, the heat taken on by the steel is expended, not in raising the temperature of the piece but in work, which produces the internal changes here taking place between the carbon and the iron. Hence, while the heat added is being taken up in this manner, the temperature of the piece, having nothing to increase it, remains stationary or, due to surface radiation, may even fall slightly. After the change is complete the added heat is again expended in raising the temperature of the piece, which increases proportionally.

When the piece has been heated above the decalescent point and allowed to cool slowly, the process is reversed. Heat is then radiated from the piece. Until the decalescent point is reached, the temperature falls uniformly. Here the internal relation of the carbon and the iron is transformed to its original condition, the work required to do this being converted into heat. This heat, set free in the steel, supplies for the moment the equivalent of that being radiated from the surface. While this condition holds, the temperature of the piece ceases falling and remains stationary. Should the rate of evolution of heat from the internal changes be greater than that of surface radiation, the resulting temperature of the piece will not only cease falling, but will obviously rise slightly at this point. In either event the condition exists only momentarily, for when the carbon and iron

constituents have resumed their original relation, the evolution of internal heat ceases and the temperature of the piece falls steadily, due to surface radiation.

The Practical Problem.—From the foregoing sections it is evident, first, that there is a definite temperature at which to best harden any carbon steel, and second, that there results great loss, both of labor and material, unless the hardening is carried out at this temperature.

The actual shop problem thus presented is to determine readily and accurately the correct hardening temperature for any carbon steel that may be in use.

[A practical means of solution, even by one who is not an expert, will follow this article at an early date, comprising a description of apparatus and methods.—Editor.]

MUNICIPAL WORK IN SOUTH VANCOUVER.

Mr. S. B. Bennett, who has recently assumed the duties of board of works and waterworks engineer for the district of South Vancouver, sends in the following summary of street improvements carried out in that municipality up to December 31st, 1913.

South Vancouver has an area of over 9,000 acres or 14½ square miles, with a population of about 40,000.

Total mileage of streets in municipality	246.5
Mileage of streets cleared and rough graded	204.0
Mileage of street uncleared	42.5
Mileage of streets macadamized	35.4
Mileage of paved roadways	3.84
Mileage of planked roadways	12.00
Mileage of sidewalks laid	117.83
Mileage of street car lines, double track	4.57
Mileage of street car lines, single track	6.02
Mileage of single track, interurban railway	4.70
Mileage of double track, interurban railway	2.08
Number of wooden bridges built	7
Number of concrete catch basins	76
Number of wooden catch basins	76
Number of concrete manholes	11
Mileage of wooden box drains and culverts	13.14
Mileage of sewers laid	.15
Mileage of storm sewers laid	2.50
Mileage of concrete curb only laid	.24

Waterworks Department.

	1910.	1911.	1912.	1913.	Total.
Miles of water mains laid	76	69	39	15	199
Fire hydrants installed	132	169	216	66	583
Services installed	2,007	2,753	2,373	1,689	8,822

Like most other municipalities, South Vancouver has been suffering from the financial depression but is looking forward to considerable activity this season. Considerable paving work is proposed. The waterworks committee is also building a steel water tank of 750,000 gal. capacity. When completed it will be 75 ft. high and 45 ft. in diameter. The cost of the tank, painted and enamelled, will be $30,000.

To preserve ste[illegible] fr[illegible] rus[illegible] [illegible] 1 part [illegible]outchouc and 16 parts turp[illegible]ntine [illegible], [illegible] 8 parts boiled oil, and mix by bringing [illegible] boiling water. Apply to the steel with a brush, the same as varnish. It can be removed again with a cloth soaked in turpentine.

REPORT ON THE MAITLAND RIVER AS A POWER PROJECT.

A REPORT on the power possibilities of the Maitland River, Ontario, is given in the sixth annual report of the Hydro-Electric Power Commission of Ontario. Since the preparation of the preceding report, continuous daily gauge readings were made at Benmiller, and these readings, with the aid of a rating curve of the stream, compiled from the regular monthly measurement of discharge, furnished the data for a further study of the hydrology of the river in its relation to the development of power.

The report contains duration curves plotted for the years 1911, 1912 and 1913, indicating that the amount of flow for economical development on this river ranges from 300 cu. ft. per second on the 212½ ordinate to 1,000 cu. ft. per second on the 152½ ordinate.

In last year's report the abnormal flow characteristics of the Maitland River were noted, and attention was drawn to the fact that any development of power must depend for continuous operation on the minimum flow of the stream in conjunction with such advantages as can be derived from local pondage.

During the summer of 1913, on a number of days the minimum flow of the stream was 75 cu. ft. per second. At the Black Hole site, with an operating head of 80 ft., this flow, without pondage, gives a minimum continuous power capacity of about 545 h.p. The local pondage above the Black Hole dam would be something over 700 acres. Assuming a maximum draw on this pond of 5 ft. (thus giving a minimum operating head of 75 ft.), a reservoir capacity of 3,500 acre-feet would be available.

An analysis of the mass curve of the Maitland River from 1911 to date, shows that 3,500 acre-feet of reservoir capacity will provide a continuous discharge of about 110 cu. ft. per sec. In extremely dry years it is probable this flow would not exceed 100 cu. ft. per sec.

From this the report ventures to state that any power development on the Maitland River at the Black Hole site could not be depended upon to deliver continuously more than 750 h.p.

The following table gives the amount of storage required for different rates of uniform draft up to 200 cu. ft. per sec., with the continuous available power for these amounts, if developed at the Black Hole:

Required Storage in Million cu. ft.	Storage in Acre feet	Uniform Flow in cu. ft. per sec.	Continuous Power Available
0	0	75	545 h.p.
80	1,835	100	725 h.p.
260	5,960	125	910 h.p.
520	11,920	150	1,090 h.p.
800	18,350	175	1,270 h.p.
1,100	25,230	200	1,450 h.p.

The table shows that for the development of 1,500 h.p. of continuous power at the Black Hole about 25,000 acre-feet of storage will be required. Owing to the fact that facilities for storage in the Maitland River watershed are lacking to an unusual degree, the purchase of land construction of the necessary works would entail an expenditure which, added to abnormal cost of development at the Black Hole, places the project, for the time being, outside of economic limits as a source of continuous power.

The rapid development in the quality of steel must be credited to a great extent to the automobile and the aëroplane. Wire [illegible] to 0.102 inch diameter, with a tensile strength of 350,000 pounds per square inch.

TORONTO WATERWORKS REPORT DISCUSSED.

The Toronto City Council has before it two reports on extensions to the waterworks system of the city. They are that submitted by R. C. Harris, Commissioner of Works, in January last, and an earlier one, presented in 1912 by a board of experts appointed in 1911 by the city. Summaries containing the fundamental points of each were published in *The Canadian Engineer* for January 22nd, 1914, and May 30th, 1912, respectively.

The later report severely criticized the recommendations of the former, and it has been, in turn, subjected to criticism of a somewhat similar nature by the engineers of the former investigating board. On January 24th, Willis Chipman, C.E., its secretary, forwarded a memorandum in which it was demonstrated that at an intake located opposite Victoria Park, the site recommended by the Commissioner of Works, the pollution of the water supply would be eight times that at the intake at Scarboro, proposed by the board of experts, this statement being based on the assumption that an intake crib be located in the same depth of water and at the same distance from shore at each of these two points.

A second memorandum forwarded by Mr. Chipman to the Board of Control recently, deals further with the two proposals. Following are interesting abstracts from it:—

"It should be noted that we recommended that the Scarboro crib be located 2 miles from shore, and at a point where the depth of water is double that at the proposed intake crib at Victoria Park. There can be no reasonable doubt, therefore, that the pollution of the supply through the Harris intake off Victoria Park, would be at least ten times greater than at the proposed intake off Scarboro Heights.

"Our designs for an intake crib have been most unfairly criticized. We did not state in our report that the structure was to be built within the harbor and floated to place, as illustrated in the diagram annexed to the Harris report. Intake cribs of the proposed height have not been sunk for waterworks purposes owing to the fact that the water in the other great lakes in the vicinities of the large cities have not the depth of Lake Ontario at Toronto, but cribs of greater depths have been sunk at other places for bridge piers and abutments, of which full descriptions are available in engineering publications.

"We also, as a board, obtained offers from responsible and experienced contractors to construct an intake crib in this depth of water, whether built of concrete or steel, who were prepared to submit bonds as a guarantee that they would carry out the work to successful completion.

"We have been taken to task by Commissioner Harris for not having made a sufficient number of borings to determine the practicability of a tunnel at the depth proposed. In explanation I may state that it was not until the latter part of November, 1911, that the board finally concluded to recommend the Scarboro project, and as we were being urged by the council and the newspapers to complete our labors, and as it would have taken another full summer season to make the borings, we decided to submit our report, in which we expressed the opinion that shale of a similar character to that beneath Toronto harbor would be found beneath the lake off Scarboro, this opinion being based upon borings made by us at the Scarboro shore upon information received from the geological survey at Ottawa, and statements made by Prof. Coleman, of the University of Toronto, who has made a special study of the Scarboro formations. The borings recently made by Smith and Travers have confirmed our opinion.

"The leakage into the tunnel beneath the harbor during construction was only about 350 gal. per min., a trifling amount. All the evidence points to the fact that the shale off Scarboro is of precisely the same character as under the harbor, practically dry and without seams or faults.

"If, however, borings should demonstrate that we made an error in judgment, there is no reason why the Scarboro intake crib could not be located in the same depth of water and at the same distance from shore as that now advocated by Mr. Harris. The Scarboro intake would then be about 7 miles from the point of pollution instead of 2½ miles.

"Before concluding our report we consulted one of the foremost tunnel experts in America, who visited Toronto at the request of the chairman of the board, examined our designs and pronounced them practicable.

Reservoir Supply.

"We propose to pump water to an elevated reservoir, not for the fun of seeing it run down hill again, but to supply all of the city north of College Street, and the higher sections not now receiving a city supply. The College Street line, which now divides the intermediate service from the lower service, was to be maintained for the present, but we anticipated that this line might be lowered; that is, some street to the southward might be adopted in the future as the northern boundary of the low level district, this lower district to be served exclusively by the present John Street station.

"Assume two municipalities, one, say, 200 ft. higher than the other—there can be no reasons advanced why they cannot be supplied by two independent pumping stations. Connecting the two systems by one or more pipes provided with check valves and gate valves, permits either area to be supplied from the other in case of emergency, as was done recently in the city of Montreal when portions of the city were supplied by the Montreal Water and Power Company.

"When enlarged and improved, the old works may be depended upon for a minimum of 60,000,000 and a maximum of 90,000,000 gal. per day. The John Street system will then meet the demands of a population of something over 500,000, which will probably be reached within the next few years.

"The supply from Scarboro reservoir might, however, be drawn upon in case of a break-down in the John Street system.

"We did not recommend or propose that the entire water supply should be pumped to a height of 370 ft. We did not propose that the new reservoir should be operated in connection with the present city system, nor with the Rose Hill reservoir, excepting in case of emergency, and all of Mr. Harris' assumptions respecting the overflowing of the Rose Hill reservoir and the interference at the John Street pumping station, rendering the old plant useless, are simply nonsense.

"In regard to reservoirs, Commissioner Harris cites several large cities without reservoirs, but he fails to state that in each of these cities there is no ground of sufficient elevation upon which to construct a reservoir. It is hardly necessary to call attention to the fact that we did not recommend the city of Toronto to construct

a mountain or hill upon which to erect a reservoir, but simply took advantage of what nature had provided.

"At Cleveland the capacity of the reservoir is over 100,000,000 gal., and dozens of cities might be mentioned where the reservoirs are of even greater capacity. If the city of Montreal had been provided with a reservoir containing 3 or 4 days' supply, the recent water famine might have been averted. At the rear of Mount Royal, a large reservoir for the Montreal Water and Power Co. is now in course of construction, and the fire underwriters and expert engineers have recommended additional storage reservoirs to lessen the possibility of water famine.

"We admit that there would be a loss of pressure due to friction. The longer the conduit and the smaller its diameter, the greater the friction, but, if I am not mistaken, the citizens of Toronto would prefer paying the trifling extra cost of pumping water through a few miles of large pipes, to the cost of the extra amount of chloride of lime necessary to disinfect a more polluted water supply, and the extra cost of filtration at the Victoria Park station.

"Furthermore, the extra cost of pumping through the mains, which would not exceed 10 or 12 pounds, would be offset by the extra cost of the pumping at Victoria Park. All of the water at this point will require to be pumped twice, first to the filters by low lift pumps and second by high lift pumps into the distribution system. No practical man will deny that pumping water twice will cost more than pumping it once to the combined height of two pumpages. The records at the John Street station and at the filtration plant, will, without a doubt, prove the above statement, but as no report of the city engineer or the public works department has been published since 1911, the public is in the dark respecting costs of operation and maintenance.

"In regard to the length of the proposed steel conduit from Scarboro westward, the distance is only four miles greater than with the Victoria Park scheme. With a new steel conduit of this length under an exceptionally light head, the possibility of breakage or interruption would be a minimum. When the population of the city of Toronto reaches 700,000 people, a second conduit will probably be required, but no one can foresee where this additional population will be distributed, and we did not, therefore, consider it advisable to include a duplicate conduit in our project. In an emergency, if the new conduit should for any reason be closed for repairs or inspection, the high level district could be supplied as it is at present by the high level pumping station, the water to be taken from the low level district and the Rose Hill reservoir.

"In regard to booster stations, the costs were not included in our report as we did not consider they would be required for a few years.

Pumping Machinery.

"In regard to pumping machinery, our recommendation was for an electric plant. The city had at that time contracted for a large block of electric power, electric pumps were being installed at the John Street station, and at the high level station, and as patriotic citizens we advocated electric power, on condition that two independent transmission lines should be constructed, also a reservoir of 130,000,000 gal. capacity.

Mr. Harris' statement respecting the pumpage of the entire water supply to a height of 370 ft. has been pointed out as incorrect. Of the 15,000,000 gal. per day now pumped at the John Street station, about 15,000,000 gal. per day is now re-pumped at the high level station, and the volume re-pumped is increasing rapidly each year. Mr. Harris' report only confirms that made by our commission.

"The maximum daily consumption in the low level district (south of College Street) is now given as about 50,000,000 gal., and in the high level districts, about 22,000,000 gal., or 72,000,000 gal. now pumped at John Street, of which 22,000,000 gal. are re-pumped at Poplar Plains station.

Pollution at Intake.

"Assuming two points near the north shore of Lake Ontario where the water is practically of the same depth and at the same distance from shore, the pollution due to the main sewer outlet near the Woodbine will vary inversely as the squares of the distances from the sewage outfall. This is axiomatic and can not be controverted.

"It must also be admitted that if the distance from shore be doubled and the depth of water also doubled, that the pollution will certainly be less than half. At Victoria Park intake, the supply under existing conditions would unquestionably be polluted at least four fold what it is at present, while at Scarboro the pollution would undoubtedly be less than one-half what it is at present, and probably less than one-fourth.

"The Harris report states that further treatment of the sewage of the city will be necessary if the water supply be taken from Victoria Park, also that the water supply should at all times be chlorinated. thus admitting the certainty of gross pollution."

ASBESTOS PRODUCTION IN QUEBEC.

The Province of Quebec contains the principal asbestos-producing areas of Canada. The present workable deposits are scattered through the great serpentine range which strikes through the townships of Broughton, Thetford, and Coleraine. The total length of the belt is 23 miles, with a width of 100 feet in the extreme easterly part, increasing to 6,000 feet in the Mock Lake area. The principal deposits are at Thetford, Black Lake, Danville, and East Broughton; the first two are the most important. The mineral occurs in a series of narrow and irregular veins, sometimes, though rarely, reaching a width of six inches. Large mills are now in operation in which the rock is broken and crushed and the fibrous asbestos is taken up from screens by suction fans, and blown into settling chambers. At present the annual production is over 100,000 tons, valued at upwards of $3,000,000. It includes a large variety of grades, from the long-fibred crude asbestos, valued at $300 a ton, down to the shortest mill fibre, valued at only $2 or $3 per ton, and "asbestic sand," used for wall plaster, and valued at from 75 cents to $1.50 per ton.

In a summary of the waterpower of the world the possible horsepower of France is estimated at 4,500,000, of which only 800,000 is utilized. About an equal amount of power is available in Italy, but only 30,000 horsepower is utilized. Falls of 10,000 horsepower are abundant in the Alps. The estimate for Switzerland is incomplete, but about 300,000 horsepower is in use. Germany has 700,000 horsepower available, with 100,000 applied. Norway has 900,000 horsepower available, with a large part already developed. In Sweden there is 763,000 horsepower available, but mostly at a considerable distance from any industrial centre. In Great Britain there is 70,000 horsepower already utilized, and an equal amount in Spain. The resources of Russia are estimated at 11,[illegible] horsepower, of [illegible] been developed. The United States is credited with 1,500,000 horsepower, while Japan has 1,000,000, of which 70,000 has been exploited; and in India 50,000 horsepower has already been developed.

TESTING OF CENTRIFUGAL PUMPS.

A CENTRIFUGAL or turbine pump is not a positive displacement pump and there are no "rule of thumb" methods of arriving even approximately at its capacity. It may be, therefore, accepted that a well-equipped testing plant is one of the most important essentials for its successful manufacture.

From the manufacturer's standpoint the records of tests carefully carried out are of the utmost value. as they constitute the foundation upon which future propositions can be based, designs developed, improved and modified to suit particular requirements. From the purchaser's standpoint, on the other hand, is the absolute assurance that the hydraulic and efficiency requirements have been fulfilled and, secondly, that a trial run of several hours' duration will ensure continuous operation of the machine with no mechanical difficulties arising after leaving the works.

There are a number of testing methods in use with varying degrees of accuracy. They may be classified as follows: Weight or volume method; weir method; velocity meters. The last group includes Venturi meters, nozzles and the Pitot tube.

The instruments required, pressure and vacuum gauges to determine the total head, wattmeters to determine input to motor, or indicator to determine horsepower of steam engines, have long been standardized and are usually accepted without question by consulting engineers and representatives of purchasers on official tests; in any case their calibration is a simple matter and ready facilities are provided for this purpose. But the measurement of the quantity of water being handled presents many difficulties because the methods generally adopted, owing to their cheapness, such as weirs, nozzles, Pitot tubes and in fact all velocity meters are open to the very strong objection that their accuracy depends on constants determined by experiment which, as far as consulting engineer or official representative is concerned, may or may not be right. A means of direct measurement either by weight or volume is an absolute necessity.

In the testing plant of Canadian Allis-Chalmers, Limited, at Rockfield, near Montreal, no one single testing method is relied upon, but any one of the three abovementioned testing methods can be used and the volume method can be used to check either the Venturi meters or the weir. It may be stated here that a testing plant established at the Mather & Platt works, in Manchester, England, served as a basis for the design of this unique equipment at Rockfield.

Figs. 1 and 2 represent views of portions of the testing plant. The overall dimensions of the tanks alone are 34 ft. 6 in. long, 18 ft. 3 in. wide and 9 ft. 4 in. deep, of such proportions as are well able to cope with the largest pumping units. All tanks have been placed underground so that factory space is not wasted and the flooring made in such a way that the tanks can be easily uncovered. The total area has been divided into three tanks; the suction tank, 18 ft. 3 in. long, 15 ft. wide, 9 ft. 4 in. deep; the calibrated delivery tank, 18 ft. long, 11 ft. wide, 7 ft. 4 in. deep, and the weir tank, which is 18 ft. long, 5 ft. 9 in. wide, 7 ft. 4 in. deep. All tank walls are made of waterproofed concrete and the bottoms carefully levelled. By raising the bottom levels of delivery and weir tanks above the suction tank, they drain by gravity through connecting valves into the suction tank. A small motor-driven centrifugal pump serves as drainage pump for all tanks. Suction pipes with foot valves and strainers of various sizes are situated in the suction tank, and little time is lost in making the suction pipe connections when pumps about to be tested are bolted to the cross rails, thus providing a firm setting-up.

The discharge connections are formed by two elbows, which connect to a 6-inch and a 12-inch Venturi meter. Following the discharge pipes, they are carried to a common large pipe, which finally connects with a water switch. By removing a blank flange, a passage can be made from the delivery tank to the weir tank. On the wall dividing the delivery tank from the weir tank is located a manometer, as shown, which, by means of pipe connections to the Venturi meter tubes, registers the amount of water flowing through the tubes. Next to this

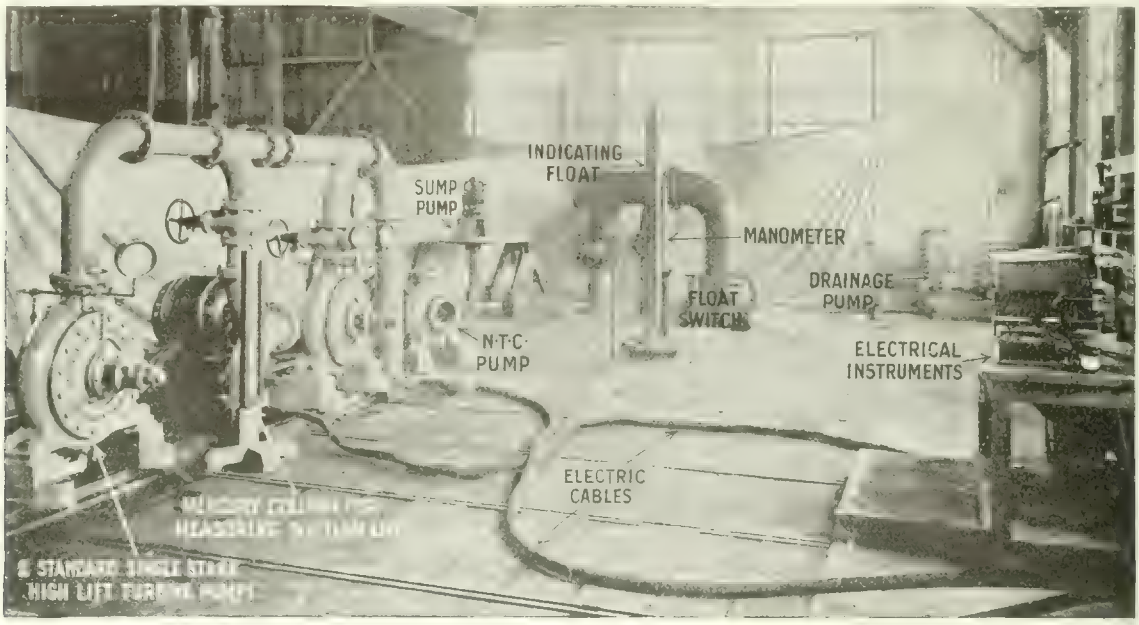


Fig. 1.

instrument is mounted a float with indicator which indicates the height of water in either delivery or weir tanks by opening and closing valves.

Referring to the weir tank, it has a cast iron weir frame, which is set in the wall dividing the weir tank from the suction tank. Weirs of the V-notch shape, and rectangular weirs of 18, 22, 24, 35 and 48-inch widths can be inserted in this frame. A ladder with a platform has been provided to allow the test operator to descend and observe the levelling and careful setting of the weir crest to the zero mark of the float scale. Baffle plates in the weir tanks can be raised or lowered in wall frames to best advantage to check any disturbances of the water and to ensure a quiet flow near the weir.

A table with the necessary electrical instruments to measure the electrical input, and engineer's desk and a fitter's bench complete the equipment.

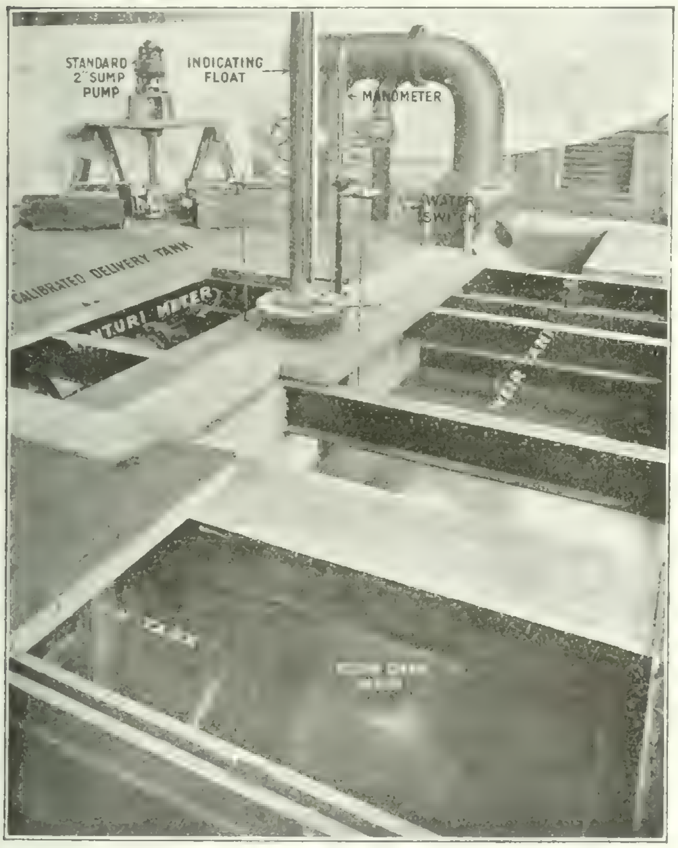


Fig. 2.

The method of test is as follows: All suction pipe connections are made with the above-mentioned pipes in the suction tank. The discharge connection is made with one of the two elbows, according to the size of pumps to be tested, and the water is discharged direct into the water switch. By operating the hand lever the water can be instantaneously switched either into the calibrated delivery tank, or into the weir flume. As the name indicates, the delivery tank, although of uniform section, has been carefully calibrated by weighing the water and noting the rise of level on the float scale. Assume the operator by means of the water switch has directed the flow into the weir flume. He observes the weir flume scale on the float and the manometer reading at the same time, thus checking the weir against the Venturi meter. Now the float is closed to the weir tank and opened to the delivery tank. The level of the water in the delivery tank having been observed and, with stopwatch in hand, the water switch lever is thrown over, allowing the water to fill up the delivery tank.

The operator allows the pump to discharge into the delivery tank for from, say, one minute in the case of 10,000 gal. per min. pumps to even half an hour if required for 500,000 gal. per min. pumps and noting the time, switches the discharge from the pump back into the weir flume whence it continues to circulate round. At his leisure and when the water in the delivery tank is quite still, the operator observes the new level and, subtracting it from the original level, arrives at an exact volumetric measurement of the water passing through the pump. Note here, also, that the water is still passing through the Venturi meters, thus checking them against the delivery tank. Thus the Venturi meter checks the weirs and the volumetric measurement checks the Venturi meter.

For any quantities over 10,000 gal. per min. the discharge is delivered direct into the delivery tank through bypass into the weir flume and over the largest weir which, having been checked up to 10,000 gal. per min., may reasonably be assumed to be exact for larger quantities.

It may also be mentioned here that steam inlet and exhaust pipe connections are available at the test plant and small or large steam turbine-driven pumps can be easily tested as motor or belt-driven units.

HYDROGRAPHIC SURVEYS IN ONTARIO.

THE stream measurement work developed in 1912 by the Ontario Hydro-Electric Power Commission was carried on continuously in 1913 with satisfactory results in the case of some rivers, and the reverse in others. The relation between gauge height and discharge was disturbed in nearly every case by ice conditions, as was to be expected. In the case of the rivers in the southwestern peninsula, such as the Grand, Maitland, Saugeen, Thames, Credit, and Nottawasaga, measurable velocities could in general only be obtained at wide shallow sections, where a high degree of accuracy in measurement could not be depended upon. The large number of mill-dams located in these streams also made it impossible to locate all gauges where they would not be affected by back-water at high stages of flow. This trouble has not yet manifested itself at the stations established on the Grand River during 1913, but it is to be expected during periods of high water.

In the case of the northern rivers, the above conditions were aggravated in many instances by the necessity of locating stations at accessible points. This usually meant the use of a bridge station, and in the case of the Sturgeon, Maganetawan, Wahnapitae, Spanish and Seguin Rivers, backwater trouble occurs intermittently owing to the operation of dams in connection with power development. The Mississaga station is seriously affected by wind levels on Lake Huron.

In the case of the Thames, Saugeen, South, Sturgeon and Credit rivers it has been found that by eliminating measurements where backwater effects are plainly evident, a fairly good station rating curve is obtainable. An effort will be made to re-locate the gauges at some of these stations so as to produce still better results.

RAILWAY TUNNELLING.

PART III.

By Leonard Goodday, C.E., M.E.

PREVIOUS articles of this series on the practical side of tunnel driving dealt with the method of procedure as followed generally in different countries. The sinking of shafts, setting out of tunnel, driving of headings, etc., were taken up in January 15th, 1914, issue of *The Canadian Engineer*. The description was continued as far as, and including in part, operations of mining and timbering, in March 19th issue, while in the following notes the discussion proceeds to the finishing of the brickwork.

From the stage at which the length under construction has been mined down to the top sill and this sill put into position the excavation must be got away quickly, as now begins the paying part of the work. Excavate down to the top of the bottom heading, placing the bars and poling farther apart. These bars may now be only a little longer than the length being mined and about 12 in. diam., one end of them being supported in the brickwork of the toothing which can be cut out for their reception, and the other end supported by temporary raking props, at a point a little back in the length from the front of the sill. About the level of the top of the bottom heading another sill is placed, the bottom of it being kept high enough to clear wagons, etc., passing through the heading. This sill is similar to the top one, but may be stronger and, of necessity, longer, because here the tunnel is nearly full width. It is placed in the same manner, letting each middle sill prop be exactly under one of those above, supporting the bars from the top sill. Two strong rakers must now be got in to support the top sill from formation, more particularly against face weight. They should be on very strong foot-blocks, and when in position, driven up tightly with driving wedges, inserted between the end of raker and the foot-block. The top end of these rakers should be formed into a jaw, to take in the bottom face angle of the sill, and should be provided with a good iron gland, just below the jaw to prevent splitting.

These top sill rakers should be got in as soon as it is possible, even before the middle sill is in, or, in any case, temporary rakers should be used. In getting out the remainder of the length, leave the sides in, and excavate the middle portion only, leaving side slopes like a cutting, and do not undermine the middle sill. Arriving at formation level, place two strong props on good foot-blocks under the middle sill, on either side of the bottom heading, and place 2 rakers to this sill, similar to but shorter than those for the top sill. The face weight is sometimes very heavy, tending to shove the sills into the length, especially when the tunnel is inverted, and in that case, besides these rakers, sill stretchers will be needed, stretching or strutting the sill ends from the last toothing. If this is not effective, "Judkin" rakers must be introduced. These are timbers abutting against one another at the centre of the sill face, and stretching it horizontally across the length to the toothing. The excavation of the slopes may now be worked, extending all to formation level across the tunnel, beginning at the top of the slope, and putting in a light bar here and there, sufficiently near to one another for them to secure the ends of any poling boards that may be required to support the ground. These bars should be supported by raking props at either end. Should the ground be good, no bars will be required below the middle sill. Do not undermine the middle sill, but leave a good footing of ground until the rest of the length is out, then take this out in bays, putting a prop under the sill from a foot-block on formation, one by one as the bays are removed.

The foundations of the side walls are usually carried down 2½ ft. below formation level and should be trenched to the net width of the lowest course of the brick footing. They must be level and solid. Any water accumulating in them can be got out by hand-pumping.

Each gang of miners should always have two faces to work, for if not, it will be idle while the bricklayers are lining. If these two faces be A and B, and the work just described as having been done in A face, while the mining of this length is going on, and before it is finished, the bricklayers should have commenced and keyed the arch of the length last got out in B face. Directly they have keyed it, some of the miners' gang in A should begin to drive the top heading for another length in B. They should be able to get the 5 bars drawn into that length before that in A is finished. There is then about room for the whole gang to get to work in this next length in B face.

By the time a few lengths are finished, it is likely that a good deal of water has been tapped, and that the method of emptying the sump by barrel is not sufficient. A steam pump is really the best and cheapest means to install. One of these occupies little space, and can be fixed in a manhole in the side wall of the tunnel, near the bottom of the shaft, and locked up. The force pipe is conducted up the shaft, and the suction into the sump, with a branch along the side wall to near the length that is being mined. To this latter can be attached a flexible hose. A stop-cock should be fitted to each branch of the suction, so that communication can be cut off from either pipe. The steam for the pump can be supplied from the winding engine's boiler.

Lining the Length.—Having the wall foundations out, everything is ready for setting the side wall frames.

The engineer should put a centre line point accurately in the middle sill, and mark off the face of the walls, and by driving a spike into the timber at any point above rail level properly distanced from the centre line. Set up the frame with its back edge against this spike, and plumb it. The projecting piece of timber marking rail level must be precisely levelled to rail level. Spike this frame securely, its place being at the leading end of the length, and close up to the sill. Put the frame up for the other wall in the same way. Four of these frames will be required for a first side length.

Bricks and mortar are now required in the length. It may be inconvenient to supply them from the open ends for all the faces, because of the number of these faces at work and the traffic in and out of the tunnel. When 8 or 10 lengths have been turned at any face, a turn-out should be put in off the main track, i.e., a siding where wagons can stand and allow others to pass them. For a tunnel of this length a mortar mill can be used in each of the entrance cuttings.

A gang for lining a length is made up of 4 bricklayers and 6 laborers—half the number being on each side and each party working on the same side of the tunnel for all lengths—so that their work will be similar throughout. The best one usually takes the leading end or toothing of the length on his side. The term "toothing" denotes leaving the bricks at the leading end projecting every alternate course, as the bond causes them

to be laid, and they then form a bond for the next length. Some prefer every length to be finished up squarely. It has a neater appearance, and is quite as strong as bonding one length into another.

A length should be complete in itself, and as one length is lined a few days before the next is commenced, there is time for settlement. If the bricks in this first length are tooth, the next, when built to it, settles also, tears out of the toothing, and becomes broken. This has to be patched, is unsightly, and suggests weakness.

Again, the courses may not be started at the same level as the last, and to get the bricks into the last toothing a little squeezing takes place, the consequence being that the first three or four bricks in every course of the new length are found to be running up or down out of the general level. A block toothing is best where bricks are used for lining. Stone side walls are another matter.

English bond is best for side walls. The first course of all wall footings may be laid dry, and the footings should have half brick projection every two courses in height. In heavy ground, however, portions of these footings are carried up plumb to formation level, i.e., full width of bottom course.

On these solid "stick-ups" set the sills and props for supporting the centre ribs. Before the wall is at rail level the courses must be level (except in the case of a gradient). At rail level leave a projecting brick near the leading end as a guide and reference. Now stretch a line from the saw cut in the wall frame, marking the courses to the corresponding course of the last length. Continue this procedure following the courses marked on the frame until springing level, the top of the frame, is attained. Grout every course and flush every joint. As the brickwork proceeds, all cavities between the back work and the mined ground must be carefully filled and packed solid.

The walls should be built up without interruption until complete to springing level, after which the centres or ribs are set. The ribs for a 5-yard length are, as mentioned before, three in number, viz., two intermediate and one leading.

The leading rib must be so placed that the laggings provided (15 ft. x 7½ in. x 2½ in.) will reach and fit between the groove or projecting sweep in the rib under the last toothing and on the one now being put up. Fix the ribs together by spiking pieces of plank upon their under sides, and drive up the slack-blocks until the crowns of the ribs are all level, and about 1 in. over sight to allow for after settlement in the work. All the necessary laggings required must be in readiness on the scaffolds standing under the last length.

One lagging is placed on each side at the arch-springing. The bricklayers put on lagging by lagging as they require them as the brickwork progresses.

The laggings will not bear on the ribs in places, when the latter have been used several times; in such cases it is necessary that wedges be used under the laggings, to keep them up to proper line, and to allow of no sagging or springing.

When the underside of the lower bar is reached, 2 laborers may then do the packing and help getting these bars out, which is done with the aid of tackle. To get a bar out it is raised a little, so that another course of brickwork can be got in to secure the ends of the poling boards that will be released by the bar. In heavy ground nearly all of the boards round the arch must be left in behind the brickwork to keep the ground from "running." When the ends of the boards are secured, the bar can be lifted out of its place, and turned round until it can be got through a bay of the ribs, and back upon the scaffold under the last length. This is often hard work where many ribs are needed, and the nearer the crown the more crowded it becomes. For the arch, English bond for the brickwork is often insisted upon, while some prefer single-ring work, i.e., all bricks laid as stretchers with bonders of headers where possible, and which is good, securing better work and less mortar used. The more bricks and less mortar there are in such a piece of work, the better the work, providing there is enough mortar to properly bed the bricks. A ¼-in. joint on the soffit, if properly radiated from the centre, will be much thicker at the extrados of the brick, and must be so if the courses are to radiate. Care must be taken, so as not to overdo this, for if there is an excess, there will be a greater settlement afterwards, and in a wet tunnel the mortar gets washed out, reducing the safety of the arch.

Returning to lining the length, the arch is built up level with the top sill, when a bricking-in piece must be introduced. It has been shown that before the top sill could be got in the bars above it had to be back-propped ahead of it, as the brickwork cannot be built further forward than the sill, and as all bars must come out as drawn sooner or later. It follows that there must be a few feet of mined ground ahead of the toothing now being formed, poled with boards, but without support. When the bars are drawn out bricking-in pieces about 8 ft. 0 in. x 6 in. x 6 in., are placed behind the brickwork between each two bars, about 3 ft. of their length resting on the brickwork and the remaining portion projecting along the roof of the mined ground ahead. They are securely packed from the brickwork before the bar is taken out, and they will then hold up the poling boards and ground.

The seventh bars are the last taking out bars. Before getting up to this height, a temporary scaffold must be made above the main one.

When the bars are all out, bricking the arch continues under the drawing bars.

The last lagging which has been put on each side must be grooved on its top edge about 1 in. deep and the length of the lagging on which rest the block lagging, which are pieces of board 1 in. thick at the ends, 2 in. thick in the centre and about 3 ft. long, used for building the key. They are laid transversely to the other laggings.

At this stage the work is very arduous and comparatively slow progress is made. Generally speaking, 55 hours is an average time in which to line a 5-yard length. It can be done in about 42 hours, however, if a full gang is kept steadily on the work. This is, on the whole, rather uneconomical as when the brickwork approaches the key of the arch working space is badly curtailed. Better practice is to withdraw the gang of men on one side until the other side has finished up to the key or within about 1½ ft. of the crown. Then the other side is finished with greater ease and better workmanship.

The brickwork completed, the bars are drawn and operations continued on the next length.

After several hundred feet of tunnel is thus completed at any face, the centre drain should be built in. In size a drain 18 x 12 in. wide is generally sufficient. The bottom should be of 4-in. flag stone, and the sides of brick or flat bedded stone laid dry. A 6-in. flag stone bedded in mortar but with joints open forms a satis-

factory cover. Its top should be at formation level, and the formation should rise from this flag towards the side walls of the tunnel, this rise to be about 6 in.

Bench marks should be plainly indicated opposite one another on the side walls, from which the height of the soffit at various points may be ascertained soon after the arch is turned. By renewing these measurements, any sinking or settling of brickwork can be noted.

REVISION OF UNITED STATES ROAD LAWS.

ROAD laws which have been on the statute books of various states of United States for more than one hundred years will probably be repealed as a result of the movement which has been inaugurated by the American Highway Association in conjunction with the American Bar Association. The committees appointed by the two associations have had prepared through the co-operation of the U.S. Office of Public Roads a complete literal compilation of the road laws of all the states, as well as the laws relating to indebtedness, the use of convict labor, and various other subjects which have a bearing upon the management of the public roads. An index chart for these various laws is now being prepared and as soon as it is completed the committees will determine upon the lines along which revision will be sought. The governors of the various states will then be asked to recommend to the legislators the appointment of special committees to confer with these committees with a view to adequate revision of existing road laws.

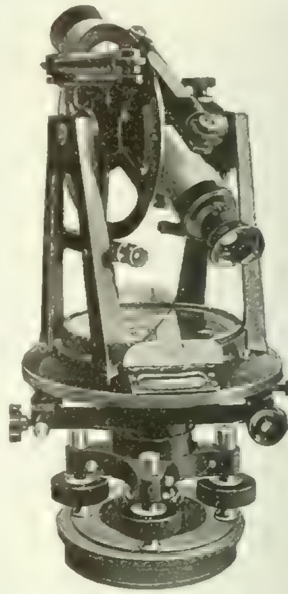
The first step in the revision of the state road laws will be to recommend that all obsolete, useless, or unnecessary road laws be repealed. The next step will be to simplify and arrange in logical order the existing necessary road laws. It has been found that in some of the states an accumulation of road laws running back over 100 years exists thus creating almost hopeless confusion. Certain basic features of good administration will be urged by the joint committees such as the payment of road taxes in cash; the elimination of a multitude of unnecessary road officials now characteristic of many of the states; the requirement of skilled supervision in the actual construction and maintenance of roads by providing qualification tests; the constant employment of highway engineers or superintendents; the adoption of the appointive rather than the elective method for such officials; the substitution of continuous maintenance for the present intermittent method; the proper utilization of convict labor where climatic and other conditions warrant its use on the public roads for the preparation of road materials; the general adoption of the principle of state aid and supervision; the proper safe-guarding and accounting of road funds.

Wherever practicable, uniformity among the road laws of the various states will be urged by the committees as it is realized that the traffic is now controlled by economic conditions rather than by state lines and should not be hampered by conflicting laws of the various communities.

It is expected that a most interesting report will be made by the joint committees at the Fourth American Road Congress which will be held at Atlanta, Ga., November 9-14, 1914.

A NEW TRANSIT.

A new transit, called the "C. E. De Luxe," is being built by E. R. Watts and Son, Canada, Limited, of Ottawa. Among the interesting features appearing in the specification for this instrument, illustrated herewith, are the following:—



Horizontal Circle—Five-inch diam., reading to 30 seconds, graduated with two rows of figures, 0—360, both ways. One row of figures with the corresponding vernier is filled in with red, while the other row and vernier are filled with black.

Bubbles—The plate bubbles are enclosed in the compass, but are adjusted outside the compass by means of capstan headed screws.

Telescope—The telescope is made by Carl Zeiss, of Jena, and is fitted with their patent internal focusing arrangement, which gives absolutely accurate readings without the use of a constant.

Foot-Screws—The foot-screws are threaded on hard German silver, whilst the milled heads are made of hard rubber. The former admits of a fine thread and an easy motion. The hard rubber millings allow of a larger diameter head without increasing the weight, and are advantageous in extremely cold temperatures.

Tangent Screws—All tangent threads are cut in German silver. The upper plate, clamp and tangent screw milled heads are of a different shape to the lower clamp and tangent screw milled heads. This enables the observer to distinguish by touch which clamp and tangent he is using, whilst to further facilitate this point they are placed in such a position that even when wearing heavy mitts their distance from the plate denotes, without having to take the eye from the telescope, which clamp and tangent is being used.

A London engineer has recently compiled figures in an endeavor to throw light upon the vexed question of whether motor traffic is more injurious to road surfaces than is ordinary horse-drawn traffic. He takes as a basis of comparison the horse traffic periods of 1905-1906, and the motor traffic periods of 1911-12 which shows a decrease in annual cost per mile of roadway, for cleansing and scavenging, in the following six London districts: Battersea and Chelsea, $540 per mile; Fulham, a decrease of $5.30 per mile; Paddington, a decrease of $620 per mile; Wandsworth, a decrease of $470 per mile, and Westminster a decrease of $895 per mile. A particular case of saving in up-keep cost is given in the example of a macadam road between Hammersmith and Barnes, which went on pieces under motor traffic. The Barnes district council spent $47,000 in relaying this stretch with block paving, and a tabulation of expenses shows that not a single penny has been spent since then in repairs to the block paved road, although the motor traffic has increased at a very heavy rate. During the horse traffic period the cost of maintaining the macadam road was $5,750 in 1906, and $1,915 during the early part of 1907, in which year the roadway was relaid.

Coast to Coast

Guelph, Ont.—The financial statement of the water commissioners at Guelph for the month of March shows a balance of $3,418.96.

Fort George, B.C.—The last spike on the G.T.P. was driven on April 7th, at the east end of the bridge over the Nechaco at Fort Fraser river.

Toronto, Ont.—The net surplus for the Toronto Hydro-Electric system in 1913 amounted to $34,576, or approximately 3 per cent. on the total investment.

St. Thomas, Ont.—The St. Thomas board of works estimates its expenditure for the current year at $19,900, which is about the same as required last year.

Victoria, B.C.—The outcome of the consideration by the Victoria council of estimates for 1914 is that the aggregate amount to be raised has been placed at $2,460,000.

Brantford, Ont.—Civic estimates for this year at Brantford provide for a total expenditure of $539,465, as compared with $472,579 last year, showing an increase of $66,886.

Montreal, Que.—Latest advices from headquarters at Montreal state that the $1,000,000 station and office building of the C.P.R. at Vancouver will be ready for opening in June.

Regina, Sask.—A new generator at the new power house at Regina has been installed, and is working satisfactorily; while another generator, which will be powerful enough to carry the whole of the lighting system of the city of Regina, is reported to be on its way.

Winnipeg, Man.—The statement has been made by Morley Donaldson, vice-president and general manager of the Grand Trunk Pacific Railway company, that the last spike on this second transcontinental railroad in Canada will be driven and the last rail will be laid on April 9.

Fredericton, N.B.—The conclusion concerning the harbor at L'Etang, reached by Mr. A. D. Swan, M. Inst. C.E., M. Inst. M.E., M. Can. Soc. C.E., who has furnished a report to the Federal Department of Public Works on ports in Charlotte county, N.B., is that this port would not be suitable for the largest class of modern merchant vessels, but, if desired, it would make an excellent harbor for steamers of moderate size.

Hamilton, Ont.—The cost of Hydro-Electric street lighting at Hamilton has now been estimated at $88,125 for one year, as compared with $65,800 previously estimated. The increase is due to extra cost of corner lights, increased area to be lighted, and the Ontario commission's decree to increase the cost. When the Hydro's $88,125 system is running complete, there will be 9,100 lights, giving a total of 1,320,000 candle-power, evenly distributed.

Halifax, N.S.—On March 24, a bill was introduced in the Nova Scotia legislature to incorporate the Nova Scotia Tramways and Power Company, which is to have a capital of $5,000,000 with power to increase it to $10,000,000. It is also provided that the bill authorizes the company to purchase the Halifax Electric Tramway Company. Moreover, the Nova Scotia Light and Power Company agrees to transfer to the new company all its rights in certain power sites and lands at Gaspereaux.

Moncton, N.B.—The I.C.R. is now constructing 165 new bridges along the lines in the eastern provinces, while by October 30 new 35-ton passenger locomotives will be put into commission. A section of road from Pasaic Junction to Oxford, 70 miles long, will also be double-tracked by that time. Another project of the new I.C.R. head is that of utilizing the short line between Pictou and Oxford Junction for Sydney freighting. This will necessitate bridging across the West, Middle and East rivers of Pictou to overcome the Westville grade.

Yorkton, Sask.—Recently at Yorkton, what may prove to furnish an adequate water supply for the town has been discovered. A supply has been struck in a test well now being dug by the town, which promises to develop into a flow amply adequate for all requirements for years to come. The new test well is 6 feet in diameter, and at a depth of 35 feet the flow of water was struck. It is now proposed to sink a 15-foot well, 50 or 60 feet; and it is confidently predicted that this will produce a water supply sufficient for a city with five times the population of Yorkton.

Kamloops, B.C.—The vertical lift span in the C.N.R. company's new girder bridge, just completed across the North Thompson river, consists of a 93-foot deck plate girder, weighing about 236,000 pounds, which is balanced by counter weights attached to cables which pass over sheaves at the top of the towers. The span is raised and lowered by means of cables fastened at the top and bottom of the towers. These cables pass over drums at each corner of the span, which are actuated by a system of gears and shafts connected to a gasoline engine at the centre. Hand operation is also provided. The machinery is designed to lift the span 53 feet in 100 seconds, providing a clearance of 55 feet above high water.

Prince Rupert, B.C.—The construction work which has been accomplished by the G.T.P. Railway company along the banks of the Skeena river to its terminus at Prince Rupert is said to be one of the greatest of railway engineering achievements. For a 200-mile section of railway, millions of dollars were spent before a shovelful of earth was removed. But along the banks of the Skeena a route has been hewn free from sharp curvature or steep grades, despite the rugged contour of the river's course, and there is no danger of the turbulent river ever being able to disturb this roadbed. Very little tunnelling has been done, for nearly 4,000,000 cubic yards of rock were blown away on 186 miles of line between Prince Rupert and Hazelton to make a route through the Cascades.

Regina, Sask.—The new reservoir to be constructed at Regina is to be a replica, with trifling exceptions, of the 5,000,000-gallon reservoir at Tor Hill. An 18-inch supply main from Tor Hill reservoir is to be laid along Halifax street, while a 42-inch main between the reservoir and the power house will be constructed on Osler street. Arrangements are also being made to connect the new basin with the proposed 27-inch supply main when the latter is constructed in 1915 or 1916. The reservoir will hold a depth of 25 feet of water and will be constructed 20 feet above the surface of the ground. It will contain nearly 500 tons of steel; will be covered with a concrete top and above the concrete a 12-inch layer of soil. In this latter respect it differs from the Tor Hill reservoir, which has no earth covering. In order to hold the earth it is proposed to plant grass seed on the top.

Regina, Sask.—The Regina incinerator was put into full operation a few weeks ago. It has been erected at a cost of $65,000, has a capacity of 110 tons of garbage per day, and has two furnaces. There are two large boilers in the plant, fans for inducing draft and for drawing off the gases, which are used to heat the boilers and create steam, etc. The steam is forced through pipes in the main furnaces, and as the damp garbage is dropped down on the grates and steam pipes, it is dried out considerably and ignition induced. Once the fires are fairly hot, the fans keep the draft in such condition that the fire burns fiercely, and it is easy to keep a steam pressure of 60 to 100 pounds on the boilers, or

enough to run the fans and a complete electric light plant of sufficient capacity to light all the buildings at the disposal works. At the present time it is only necessary to run one furnace at a time, in order to take care of all the city's garbage.

Vancouver, B.C.—The creosoted wharf to be constructed at the site of the proposed Marine and Fisheries building on the Soughees Reserve, for which the contract has just been let to Messrs. Parks, Tupper and Kirkpatrick, of Vancouver, will be 420 feet in length; and on the north side it will run inshore 224 feet. It will be 50 feet wide and will be 6 feet above high water mark. A considerable amount of dredging has been carried out during the past few months in order to give 20 feet of water at low tide; and the foreshore will be graded to a uniform level, giving a gradual slope toward the wharves. On the graded site it is proposed to build the new Marine and Fisheries Depot. The contract calls for the excavation of 27,000 cubic yards of material, composed mostly of clay. It is probable that the whole of the grading will be completed within six weeks after an actual start on the work. The wharf should be completed within four months, and before the expiration of that time it is probable that the contract for the Marine and Fisheries building will be awarded.

Edmonton, Alta.—The final plans recently filed for the route of the Canadian Northwestern railway, or the C.N.R extension into the Peace River district of Alberta, show that from Whitecourt, to which point at the confluence of the McLeod and Athabasca rivers the grade has been completed, the line will follow the valley of the Athabasca for about 50 miles on the south side, crossing the McLeod by a separate bridge. It will cross the Smoky river about 3 miles from the [illegible] of Grande Prairie, between Saskatoon and Bear Lakes. After crossing the Athabasca and leaving the valley for the north the route goes through township 62, range 18, townships 63, 64, and 65, range 19; township 66, ranges 20 and 21; township 67 and 68, range 22; townships 68 and 69, range 23; townships 69 and 70, range 24; township 70, ranges 25 and 26; township 71 and as far west as range 6, west of the 6th meridian; township 72, ranges 7 and 8; township 75, ranges 9 and 10; township 74, ranges 11, 12 and 13, to the Alberta-B.C. boundary.

Toronto, Ont.—Over a million dollars of the five million good roads grant by the Ontario government has already been expended in the north, according to the report which J. F. Whitson has submitted to the legislature, through W. H. Hearst, minister of lands, forests and mines. In this outlay, which reaches exactly $1,081,172.28, road construction of 764 miles has been completed during the past year. In all, 279 miles of bush roads were cut, the most of which are in the district of Temiskaming, in the vicinity of Cochrane, Porcupine, Iroquois Falls, from the Quebec boundary, 125 miles to Ground Hog; also a 50-mile strip from Haileybury to Englehart, Matheson, Charlton and Swastika. Mining roads were also extended into the Kirkland Lake Goldfields and Shining Tree. The estimated expenditures for 1914 amount to $950,000, of this Rainy River gets $85,000; Port Arthur, $60,000; Fort William, $90,000; the Soo-Sudbury road, $90,000. The largest individual grants go to the T. and S.N.O. and T.N.R. districts, these receiving $120,000 and $105,000, respectively.

Edmonton, Alta.—Route plans for 18 miles of the Central Canada Railway north of Edmonton have just been filed in the provincial department of railways for Alberta. These show that 60 steel and wooden bridges, ranging from 75 to 125 feet in length, will be required on the line, which will connect with the Edmonton, Dunvegan, and British Columbia railway at Round Lake, and will continue along the North Hart river to Peace River Crossing. It is also stated by the railway engineers that at least 50,000 yards of earth will have to be removed from every mile of line on the right-of-way along the North Hart river; and it is estimated that the construction cost of this stretch of line will be more than $50,000 a mile. The sliding banks along the tortuous windings of the North Hart river are fully 700 feet above the high water level. The grade drops that distance in the 18 miles of line before reaching Peace River Crossing, where the railway company will span the Peace River with a steel bridge costing $400,000. Thence the line will continue to Dunvegan along the north bank of the Upper Peace River.

PERSONALS.

C. B. CARTER, for two years municipal engineer of West Vancouver, has resigned.

A. J. DONEGAN has been appointed superintendent of the Algoma Eastern Railway, with headquarters at Sudbury, Ont.

E. I. SIFTON has been appointed general manager of the Hamilton Hydro-Electric System, and W. H. CHILDS will be his assistant.

C. M. ARNOLD, formerly city engineer of Lethbridge, has resigned his position with the Canadian Pacific Railway, as engineer of ditching operations in Alberta.

J. E. PENNYBACKER, who has been advisory expert for the Ontario Highway Commission, has resigned as secretary of the American Highway Association to accept the

J. E. Pennybacker.

position of Chief of the Division of Road Economics in the Office of Public Roads, United States Department of Agriculture.

HERBERT DOUGLAS, lately of the mechanical department of the Canadian Pacific Railway Company, and formerly foreman of the erecting department of the Consolidated Mining Company at Trail, B.C., has received the provincial government appointment of assistant inspector of factories for British Columbia.

L. P. BURNS, A. SCULLY and J. T. LENNOX, president, secretary, and a director, respectively, of the Inland Construction Company, Limited, of Toronto, who recently secured the contract for the Swift Rapids section of the Severn river division of the Trent Canal, were in Lindsay last week following up their plans for undertaking the work. It is announced that Ragged Rapids will be made headquarters, and that a road will immediately be built from there to Swift Rapids.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page [illegible], a directory of such societies and their chief officials.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

At the monthly meeting in Montreal of the Canadian Society of Civil Engineers on April 9th Mr. L. S. Bruner, of the Canada Cement Company, read a paper, entitled "Concrete Road Construction," and Mr. G. Henry, chief engineer of the Highways Department of Quebec, presented one on "Road Improvement in the Province of Quebec."

Mr. Bruner's was a most interesting address, illustrated by lantern slides showing types of roadway construction and illustrating the use of concrete to good advantage. Among others were views of the King Edward Highway, which, it is planned, will be officially opened during the Canadian and International Good Roads Congress in Montreal, May 18th to 23rd.

Mr. Henry's paper was read by Mr. R. A. Ross. It pointed out that in Quebec there were 45,000 miles of roads, including the mud tracks and trails of the colonists, the latter being little more than navigable and received very little traffic. Next to them were the by-roads, made of graded earth, which for a long time to come would need nothing but grading and draining. These were followed by the class of roads, which required artificial surfacing in order to meet traffic requirements, while the final class was the series of trunk roads or provincial highways connecting with big cities.

Mr. Henry stated that with the widespread system of roads in the province and the enormous amount of work to be done, the cost of improvement would mount so high that the present generation could hardly hope to see much improvement. The best that could be hoped would be for the improvement of the most-needed roads during the next few years. The general idea was that such work as was possible should be done on the ordinary roads, while the highways "de luxe" should either wait their turn or pay for their accommodation.

He warmly recommended the efforts of the Provincial Government to extend the work on highway improvements, especially advocating the straightening out of provincial roads so that a railroad crossing the same distance on either side should be at least 3,000 feet. A rather surprising feature of his address was the fact that the average annual period for such road work in this province was only 100 days, the rest being used up by winter and rainy days. The general conclusion was that the ancient system of statute labor and the "share system" should be dropped in favor of the municipally organized road building system.

Mr. H. H. Vaughn was chairman of the meeting.

"OIL SEEPAGES IN BRITISH COLUMBIA."

This was the subject of an address given recently by Mr. F. J. Crossland to the Vancouver Chamber of Mines. Owing to the desire of the British Government to secure an adequate and well-distributed supply of oil for naval use, the subject is one of great interest in the Province. The well-established oil fields of Mexico and California and the indications that are in evidence northward, have acted as a stimulus to oil investigations in British Columbia. Mr. Crossland stated that it was the intention of the Dominion Government to send a corps of experts to British Columbia this season to conduct exhaustive examinations of the carbonaceous deposits.

TORONTO SECTION A.I.E.E.

The fifth regular meeting of the Toronto Section of the American Institute of Electrical Engineers will be held in the Engineers' Club on Friday evening, April 17th, 1914, at 8.15 p.m. Mr. C. G. Spencer, Mechanical Engineer of the Toronto Power Company, will present a paper, entitled "Standby Steam Stations for Overhead Transmission Systems."

CANADIAN FORESTRY ASSOCIATION.

The officers for the current year of the Canadian Forestry Association are: President, William Power, M.P.; vice-president, F. C. Whitman; secretary, James Lawler, Journal Building, Ottawa.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—**Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.**

AMERICAN PEAT SOCIETY.—**Eighth Annual Meeting** will be held in **Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.**

AMERICAN SOCIETY FOR TESTING MATERIALS—**Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-**Treasurer, **University of Pennsylvania, Philadelphia, Pa.**

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—**To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.**

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

The American Railway Engineering Association's annual convention was held at Chicago, Ill., March 17-20. The committee reports dealt with included those on rules and organization, signals and interlocking, yards and terminals, roadway, wooden bridges and trestles, iron and steel structures, masonry, track, electricity, wood preservation, grading of lumber, water service, buildings, rail, ties, signs, fences and crossings, conservation of natural resources, economics of railway location, uniform general contract forms, records and accounts, and ballast.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21565—March 2[illegible]—Authorizing G.T.R. to construct siding into premises of Canadian Buffalo Forge Co., Limited, on Lot 18, city of Berlin, Ontario.

21566—April 1—Approving Montreal and Southern Cos Ry., Co.'s Standard Freight Tariff C.R.C. No. 1; to become effective on April 13th, 1914; said tariff with copy of this Order to be published in at least two consecutive weekly issues of Canada Gazette.

21567—March 31—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal to take additional 25.8 ft., property of Joseph Bissonnette, parish of St. Joseph de Soulanges, Co. of Soulanges, Que., for its transmission line.

21568—April 1—Authorizing Lake Erie and Northern Ry. Co. to construct bridge across Lynn Pond and Lynn River, at Simcoe, Ont.

21569—March 31—Authorizing C.P.R. to construct bridge No. 19.86, on Farnham Subdivision, Eastern Division, across Richelieu Street, town of St. Johns, Que.

21570—March 30—Authorizing C.P.R. to construct spur for International Linseed Oil Co., at Moose Jaw, Sask.

21571—March 30—Authorizing C.N.R. to construct extension of spur, already constructed, to gravel pit, Lot 45, Tp. McIrvine, Rainy River District, Ont., and to cross Government Colonization Road and Rainy River Road in said Lot 45.

21572—March 31—Approving location C.P.R. station in Lot 17, Con. 7, Tp. Mara, Co. Ont., Ont., at Schepler, mileage 51.4, on Port McNicoll Subdivision, Ontario Division.

21573—March 28—Authorizing C.L.O. and W. Ry. (C.P.R.) to take, without consent of owner, certain lands for purpose of affording access to station grounds in town of Oshawa, Ontario.

21574—March 30—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional 28.9 ft. for transmission line, across Lot 142, parish St. Joseph de Soulanges, Co. Soulanges, Que., property of F. X. Menard.

21575—March 30—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional 25ft. for its transmission line, across Lots 309, 310, property of Francois Valade, and Lot 14, property of Mrs. J. A. Lerous, parish of St. Joseph de Soulanges, Co. Soulanges, Quebec.

21576—April 1—Granting leave to Midland Ry. Co., to lay pipes under industrial tracks of C.P.R., lying between Erin and Clifton Streets, city of Winnipeg, Man.

21577—March 31—Approving location and design of G.T.R. proposed new station at Edfrid, Ont.: Provided, whenever traffic on highways is blocked for more than five minutes, at any one time by reason of location hereby approved, Board shall be at liberty to re-locate said station.

21578—March 31—Directing that within 90 days from date of this Order G.T.R. install improved type of automatic bell at first public highway west of South Indian, Station, Ont.

21579—April 1—Relieving G.T.R. from providing further protection at crossing of 2nd highway east of Carlsbad Springs, Ont.

21580—April 2—Authorizing C.P.R. to reconstruct two bridges—namely, No. 24.0, Brockville Subdivision over Irish Creek, near Jaspar, Ont., and No. 2.9, Fredericton Subdivision, over Three Tree Creek, near Fredericton Jct., N.B.

21581—April 2—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional width of 25 ft. across Lots 126 and 123, property of Victor Juillette, and Lot 129, property of Hormisdas Legros, parish St. Ignace du Coteau du Lac.

21582—April 2—Approving location C.P.R. station at [illegible], B.C., [illegible] Kootenay Central Railway.

21583—April 2—Ordering and Declaring that Bank of [illegible] New Westminster [illegible] is authorized and re[illegible]quired to pay to G.N.R. or its order sum of $1,222.50 deposited by Delta Shingle Co., Limited, to order of Board under Order No. 18508.

21584—April 3—Authorizing C.P.R. to construct spur for Fernie-Fort Steel Brewing Co., Limited, Fernie, B.C.

21585—April 2—Authorizing C.P.R. to use and operate bridges—namely, Red River Bridge, Winnipeg Terminals; No. 0.41, Fort William Terminals; 131.3, Brandon Subdivision, and 63.3, Lac du Bonnet Subdivision.

21586—April 2—Authorizing C.P.R. to construct spurs (1) for the Manley and Slater Automobile Co., Moose Jaw, Sask., (2) Canadian Standard Automobile and Tractor Co., Limited, Moose Jaw.

21587—April 3—Authorizing T.H. and B. Ry. to construct spurs in city of Hamilton, Ont., for Hamilton Bridge Works, Co., Limited.

21588—April 3—Approving C.N.Q.R. plan showing proposed arrangement of signals at crossing of C.P.R., at L'Epiphanie, Que.

21589—April 3—Authorizing Point aux Trembles Terminal Ry. to construct across Notre Dame Street, east on Island of Montreal, parish of Pointe aux Trembles, Que.

21590—April 3—Suspending C.P.R. Co. Tariff, C.R.C. No. E. 2765, and G.T.R. Tariff C.R.C. No. E. 2896, covering proposed new rules governing milling-in-transit of grain, pending investigation by Board.

21591—April 4—Amending Order No. 21558, March 26, 1914, by striking out the words, "National Steel Car Company, Limited," and substituting therefor the words, "Dominion Power and Transmission Company, Limited."

21592—April 3—Authorizing, upon certain conditions, the Pointe aux Trembles Terminal Ry. Co., to construct its lines and tracks across the lines and tracks of the C.N.Q. Ry., in the parish of Pointe aux Trembles, P.Q.

21593—April 2—Authorizing the G.T.R. to construct certain bridges on its line of railway.

21594—April 2—Requiring G.T.R. to flag all train movements over crossing of Bridge Street, Niagara Falls, Ont.

21595—April 2—Relieving, for the present, the G.T.R. from providing further protection at the crossing of Light Street, Woodstock, Ont.

21596—April 4—Authorizing the Can. Nor. Alta. Ry. to construct its line of railway across and divert the North and South Road Allowance, in Sec. 31, Twp. 54, Rge. 27, W. 4 M., Alta., at mileage 15.0.

21597—April 3—Ordering the C.N.O. and the C.L.O. and W. Rys. to widen out the approaches at Mary Street to 24 ft. and provide protection fences; to widen approaches at James Street to 24 ft., and to construct sidwalk on west side of crossing, in the city of Belleville, Ont.

21598—April 6—Amending Order No. 21457 by striking out the word "Ontario" under the heading "Province" in the operative part of the Order and substituting therefor the word "Quebec."

21599—April 1—Authorizing Cedar Rapids Manufacturing and Power Company to take lands O. Leroux, G. Methot, H. St Denis, and L. Brisbois in the Co. of Soulanges, Que.

21600—April 6—Authorizing the C.P.R. to construct a branch line for M. M. Cummings, Westboro, Ont.

21601—April 6—Authorizing C.P.R. to construct road diversion in Con. 16, Twp. 2, Rge. 15, W. P. M., Man., by grade crossing.

21602—April 6—Authorizing C.N.O.R. to cross Davenport Road, Toronto, by means of structure carrying highway over the railway.

21603—April [illegible]—Authorizing C.N.O.R. to cross St. Clair and [illegible] Avenues, Toronto, by means of structure carrying the highways over the railway.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

ROGER'S PASS TUNNEL OF THE C.P.R.

THE FIVE-MILE, DOUBLE-TRACK TUNNEL UNDER CONSTRUCTION THROUGH THE SELKIRK MOUNTAINS, LOWERING THE GRADE 540 FEET AT THE SUMMIT AND REDUCING THE DISTANCE BY 4½ MILES—NOVEL METHOD OF CONSTRUCTION EXPLAINED.

THE Canadian Pacific Railway is now constructing one of the most important engineering works ever attempted on this continent—the boring of a 5-mile, double-track tunnel through Mount Macdonald, one of the peaks in the Selkirk Range. The purpose of it is to obviate the present necessity of using two long spiral loops on the western slope, and many miles of snow sheds, the improvement being designed to effect a considerable grade reduction and the abandonment of what is considered from the operating standpoint one of the most costly sections of railway on the entire system.

Fig. 1.—Approaches to the Roger's Pass, showing (on the left) Mt. Macdonald and (on the right) the Illecillewaet Valley, British Columbia.

The tunnel, when completed, will be the longest in America, measuring exactly 26,400 feet, and surpassing the Hoosac tunnel on the New York Central line, the longest at present, by three-quarters of a mile. It has associated with its construction, the building also of over 18 miles of new main line. The views shown in Fig. 1 illustrate the nature of the region it penetrates, while the map and profile (Figs. 2 and 3) show its relative position and that of the old and new main lines of the Canadian Pacific Railway through the Selkirks.

Since the C.P.R. first opened its transcontinental line through the mountains of British Columbia it has expended millions of dollars in protecting and renewing its tracks, on extra locomotives for the heavy grades, and in coping with snowfalls and other physical handicaps which keep a large force of men and a large amount

of expensive equipment busy nearly all the year. At Roger's Pass, close to the summit of the Selkirks, the company maintains large engine sheds, shops, snow-ploughs and outfits ready for service on both sides of the Selkirk range.

For many years the company has been gradually effecting a reduction of its gradients and improving its main line generally in preparation for the development of the grain traffic westward from the prairies. In connection with this policy the C.P.R. four years ago bored two spiral tunnels through Mount Cathedral and Mount Ogden in the Rocky Mountain range, eliminating what was known in railway circles as the "big hill" between Field and Hector.

As traffic conditions are at present, on the westbound trip through Roger's Pass trains start the ascent of the Selkirks at Beavermouth, 28 miles west of Golden, which is at an altitude of 2,435 feet and is the most northerly station on the route. The summit of the range is 4,351 feet above sea level. Before reaching Beavermouth, the railway crosses the Columbia River to the base of the Selkirks, which, in direct contrast to the slopes of the locomotives used on the steep grades on each side of the summit.

The gorge of Bear Creek leads into a ravine between Mount Macdonald on the right and Mount Tupper on the left, entering Roger's Pass through a narrow defile.

The Pass derives its name from Major A. B. Rogers, explorer, who first penetrated the Selkirks in 1881, and discovered the narrow, rocky defile.

Passing between two serrated lines of peaks the railway proceeds to the actual summit, 4,351 feet above sea level, and thence starts the descent into the Illecillewaet Valley. The road to Glacier has a descent of 258 feet in the two miles of the summit.

The new location for the line under the Selkirks branches off from the present route near Cambie, three miles west of Glacier, and from Cambie the approaches of the tunnel run in almost a straight line to the base of Mount Macdonald, as shown in Fig. 2.

The western portal will be located about 1,700 feet below and a short distance west of Glacier House. The main passage will provide for double tracks and the approaches from both ends will also have parallel lines.

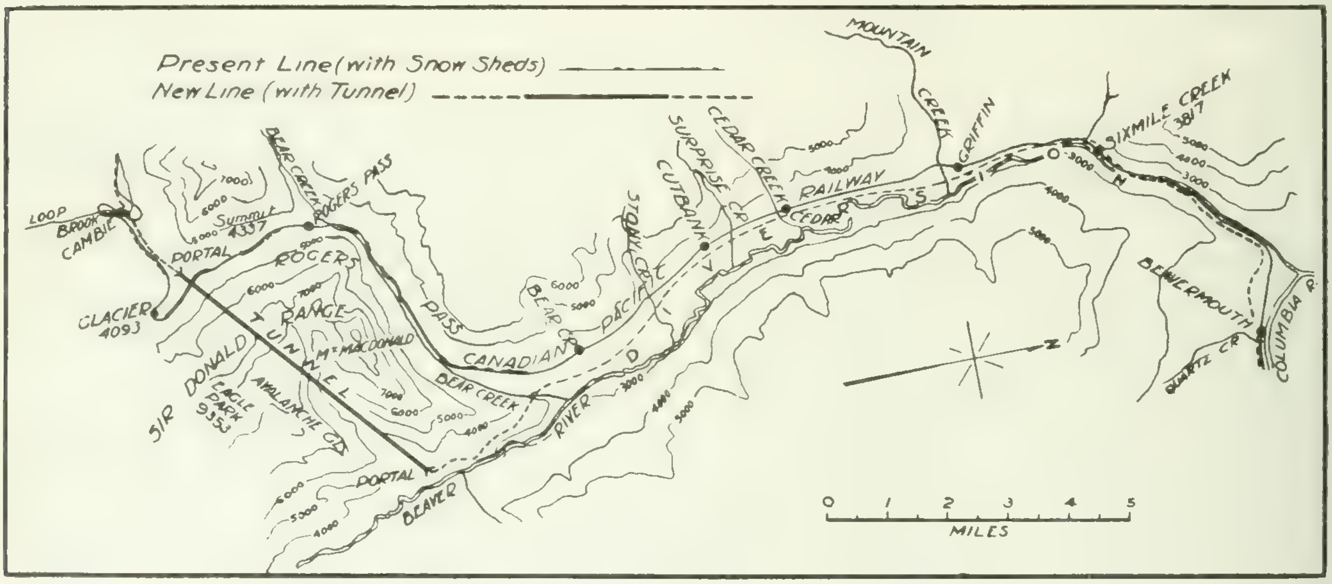

Fig. 2.—Map Showing Location of Roger's Pass Tunnel and Projected Railway Line.

Rockies, are always wooded. The line gradually climbs upward and enters the Selkirks through the gate of the Beaver River. Six Mile Creek, 5 miles west of Beavermouth, is the junction point for the new location which leaves the present route, rising at an average rate of 160 feet in the mile, and descends into the Beaver Valley, following the river to the eastern portal of the tunnel under Mount Macdonald. The scene of the operations is more than 1,000 feet below the present track level and is about 12 miles west of Six Mile Creek.

The railway parallels the course of Bear Creek after leaving the station bearing that name, following a continuous upward grade through nearly 5 miles of sheds, erected at tremendous cost to ensure the safety of trains from the slides which frequently occur. These sheds are built of stout framed timber, dovetailed and bolted together and set and reinforced with rock.

Between Bear Creek and the summit, and for a corresponding distance on the western slope of the Selkirks, men are kept constantly employed for eight months of the year keeping the lines open for traffic. Roger's Pass is the headquarters for the clearing outfits and the extra

The tunnel will follow a straight line under Mount Macdonald emerging in the Beaver Valley at a point about 1,000 feet below the present line which, as stated, reaches the summit by a gradual incline on a route notched out on the eastern slopes. The eastern entrance is situated almost immediately below Hermit, a flag station east of Roger's Pass and nearly 47 miles west of Golden.

By the route thus chosen the old line, with its long 2.2% grades, reaching a summit elevation of 4330.37 ft. in the pass, will be replaced by a new line whose summit is 540 ft. lower, effects a saving of 4½ miles in distance, and has the special advantage of eliminating a stretch of line subject to frequent troubles from snow and requiring long stretches of snowsheds. The present line has nearly five miles of snowsheds in 13 miles, while the new line will have only about 4,800 ft. The maximum grades on the new line are 2.2%, but their total length is less than one-third of those on the old line. The total curvature is also reduced considerably and two loops are eliminated. Thus while the maximum train load will remain the same, the operating conditions will be very much more favorable in consequence of the lower elevation, the shortening of the

heavy grades, and the reduction of the expense and delay due to snow. A comparison of the two lines is made in the accompanying table.

Comparison of Old and New Lines at Roger's Pass.

	Old line open summit.	New line summit tunnel.
Length, between same points..	23 miles	18 miles
Max. grades (compensated) ...	2.2%	2.2%
Length of max. grades........	22.15 miles	6.61 miles
Grade through tunnel (tangent).	....	0.98%
Summit elevation	4,330 ft.	3,791 ft.
Sharpest curves	10°	10°
Max. train load	870 tons	870 tons
Track	Single	Double

have the big undertaking finished by December 31, 1916, 3½ years from the time the work was started. Building a passage 5 miles long is a lengthy process in the ordinary way. Only a limited number of men can work in the heading at one time and delays constantly occur on account of blasting and other causes. With the pioneer bore, the work will be greatly facilitated. The side drifts leading into the course of the main tunnel will enable the drillers to attack a number of points at once. While blasting is proceeding in one part of the shaft the workers will be able to continue their activities in another instead of having to cease work each time a shot is fired, as would be the case with the one heading. The same applies to the excavation part of the work. Lines of cars loaded with material can be kept continually in motion from the various drifts.

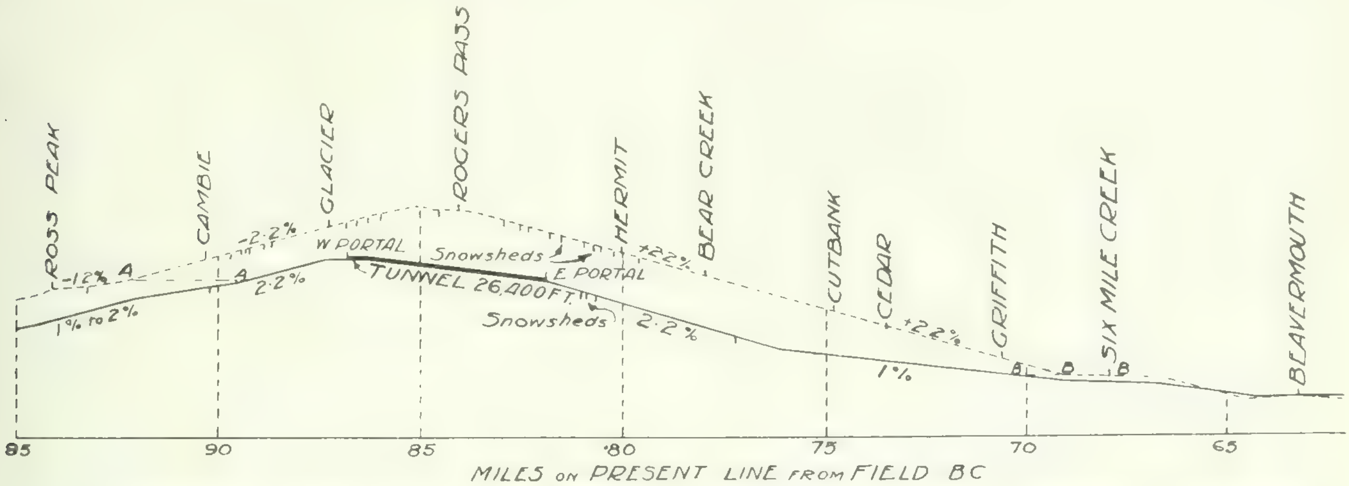

Fig. 3.—Present and Projected C.P.R. Lines Through Selkirk Mountains, Showing Location of Tunnel and Comparison of Grades.

For about 1,100 ft. at each end of the tunnel the material encountered consists of clay and boulders. The balance is expected to be in solid rock, mica schist and quartzite, so far as can be judged from the investigations made. The maximum depth of rock above the tunnel will be 5,690 ft. In cross-section, the tunnel will be 24 ft. high and 29 ft. wide, with concrete lining through the softer materials.

Method of Construction.—The contractors who have in hand the tunnel scheme are applying an entirely new method of tunnel piercing. A pioneer heading or tunnel 7 x 9 ft. in cross-section is being driven 45 ft. from the centre line of the main tunnel and with its grade 10 ft. above the subgrade of the latter. From this pioneer tunnel crosscuts will be made to the line of the main tunnel at such distances as may prove desirable, probably 750 to 1,000 ft. apart. Drifts from these crosscuts will be driven along the centre line of the main tunnel, from which drilling and shooting can be carried on while mucking will be done with air-operated shovels in the enlarged section of the main tunnel. The muck will be handled by 16-yd. side-dump cars and compressed-air locomotives. The drills and ventilating fans will also be operated by compressed air. The idea is quite in the nature of an experiment and was decided upon only after careful calculation and mature consideration. One of the principal reasons for its adoption was the fact that the C.P.R. wished to

Another great advantage is the fact that the pioneer bore will act as a ventilating shaft, enabling the passage of a current of air through two bores and the connecting passages. It will also serve a permanent purpose in the same connection on the completion of the main tunnel. This pioneer bore was started last autumn.

The work is pursued in much the same way as in the levels of a mine. Stopes are driven and holes are bored with air drills, charges set and exploded and the shattered material placed on cars and run out along

Fig. 4.—Eastern Portal of Roger's Pass Tunnel.

narrow gauge tram lines. Electric fans keep a current of air in circulation, removing the dust from the drills and clearing the atmosphere of the poisonous gases from the blasting. Gangs of drillmen will be employed in three

continuous shifts on the tunnel excavation work, which will be prosecuted from both ends at the same time. Work on the pioneer bore has been advanced at the eastern portal over 1,100 feet into the mountain, and a start has also been made on the main bore from the east end. Operations will be commenced on the preliminary shaft and the large tunnel at the western end at an early date. The excavations for the approaches at both sides are 50% completed and the wall plate heading at the east portal was started early in February. The headings will be continued, timbering carried on and bench excavated by the air-shovel until rock is encountered.

Work on the cuttings is being pressed night and day, two shifts a day being employed outside. A force of 500 men is now engaged, 300 of whom are at the western end and 200 at the eastern section. Special gangs were engaged constantly during the winter months keeping the working tracks clear of snow. Naturally, a large amount of machinery is used by the contractors, among the equipment being compressor plants for the air drills, large steam shovels, lighting plants and motors of various kinds.

Fig. 5.—Entrance to the "Pioneer" Bore.

The Roger's Pass tunnel and relating double tracking was decided upon last spring, preliminary operations being started last June. Before the work could be commenced on the excavation for the approaches, sidings had to be installed on either side of the mountains, camps established, trails and roads built and other organization details given attention. Some 50 per cent. of the excavation for the right-of-way on the western section of the work has already been done and 40 per cent. at the eastern side.

One of the engineering feats carried out in connection with the tunnel undertaking was the diversion of the course of the Illecilewaet River. The stream, which during the spring freshets assumes great dimensions, presented a serious handicap as its original channel crossed the location for the approaches at a point where a deep cutting had to be excavated to secure the necessary grade for the entrance of the tunnel, and then skirted the route for a considerable distance. While measures could have been taken effectively for carrying the tracks on trestles or bridges there would have still been a danger of the river encroaching on the line or undermining the roadbed, and so it was decided to change the course of the stream. To accomplish this purpose and to prevent future trouble, a deep trench, nearly a mile long, was dug on the left side of the approaches. This will act as a continuation of the original channel of the river and will divert the stream past the cutting to a point where an arched culvert will turn the water under the tracks again into the old creek bed on the right side of the railway.

The tunnel contract covers 8 miles of the improvement scheme which will extend to Six Mile Creek, and includes the construction of the line from the junction point at Cambie to a point about a mile on the other side of the eastern portal. A contract will be let later for the double-track connections further east.

Model villages have been established by the contractors on both sides of the mountain. The buildings are all equipped with electric light, steam heating, hot and cold running water, sanitary plumbing and other conveniences not usually found in the ordinary railway camp. Roomy dining rooms and sleeping quarters are provided for the men, the houses being connected with covered passageways raised above the level of the snow. Quarters for the clerical and engineering staffs of the contractors and the C.P.R. are provided in separate buildings. Emergency hospitals are maintained at both villages and each village has a regular police force. The executive offices of both the C.P.R. and the contractors are located at the west portal camp.

Two different kinds of weather are often experienced at the two sections of the tunnel project at the same time. At the western end the temperature may be comparatively mild while a few miles distant on the other side of the range it may be considerably below zero. More snow falls on the western slope than on the eastern side. Last winter 57 feet of snow was recorded at Glacier. This year's snow-fall has been the lightest in many years, although 37 feet was recorded.

The work is under the direction of J. G. Sullivan, Chief Engineer of the Canadian Pacific Railway (Western Lines). F. F. Busteed is engineer-in-charge, covering grade revision and double tracking as well as the tunnel. It is not without interest to observe in passing that Mr. Sullivan was first assistant engineer to Mr. John F. Stevens when the latter was chief engineer of the Panama Canal, prior to the advent of Col. Goethals. The undertaking is being carried out for the C.P.R. by Messrs. Foley Bros., Welch and Stewart, railway contractors, of Winnipeg. Mr. A. C. Dennis is the superintendent in charge for the contractors, and J. Roberts is in charge of office work. Mr. J. D. Shepperd is the railway company's tunnel engineer. Under Mr. Shepperd are two resident engineers, Mr. H. R. Phipps at the eastern end and Mr. D. Macgilp at the west. Westinghouse, Church, Kerr & Company have been retained as consulting engineers to investigate and report upon the proposed electrification of the tunnel. The relative economies of steam and water power and the effect of electric motive power on operating conditions in that region will determine the system of electric traction adopted.

TRAFFIC THROUGH THE SUEZ CANAL.

In December, 1913, 451 vessels carrying 2,100,000 metric tons of merchandise passed through the Suez Canal. Of these ships 231 were eastbound and 220 were westbound. Of the former 143 had cargoes amounting to a total of 1,055,000 metric tons as compared with 783,000 metric tons carried through the canal eastbound in December, 1912. Of the 220 vessels bound west, 150 had cargoes and carried 1,144,000 tons as compared with 1,260,000 tons during December, 1912. Of the total number of vessels which passed through the canal, 102 were mail steamers, and of these 50 were going to the east and 52 had destinations in the west.

MODERN ROAD WORK.

In a paper presented before the Roads Improvement Association of Leicestershire, Eng., Mr. H. P. Boulnois, vice-chairman of the association and a member of the engineering advisory committee of the Road Board, dwelt upon the subject of modern road methods. He laid the revolution which obtains in our preconceived methods of road building to the introduction in large volume of self-propelled traffic, which had thereby raised considerable public and scientific interest in a question which had lain dormant and neglected for many years. The year 1908 brought with it the public outcry against the dust nuisance, and the excessive damage caused to the water-bound carriageways of this and other countries by the new description of traffic. Road makers became naturally much exercised in their minds at the outcry, and at once set to work to ascertain how this great change in the character of the traffic was to be met.

Three International Road Congresses have been held since then, the first at Paris, the second at Brussels, and the third in London. Extraordinary interest in the proceedings was shown at all these congresses, which were attended by delegates from all parts of the civilized world. Many interesting questions were discussed, but no very definite conclusions could be arrived at—beyond generalities—the fact being that there are so many conflicting and disturbing factors which enter into the question as to what should be the form of construction of the modern road surface.

The traffic on the road is the primary factor which governs the selection of the type of construction to be employed. The amount and description of this traffic varies in almost every locality, and the problem is further complicated because this traffic is in a state of transition. We have to deal with the self-propelled traffic of varying speeds and weights, but also with the horse-drawn traffic, and a surface that may be excellent for the one may not be the best for the other.

It has been stated, with some truth, that the bicycle requires a road as smooth as a billiard table, a traction engine, or heavy motor wagon, requires a solid stone causeway, a horse requires a soft and easy foothold, and that a rapid motor car requires a straight track all to itself. In addition to this, the pedestrian requires a footpath for safety, and there should be little or no dust, a requirement which is shared by the occupiers of adjoining premises; also there should be a minimum of noise. The ratepayer, who pays for the road, naturally requires that the construction and maintenance should cost as little as possible, while all the users of the road require that it shall be amply wide, so that there shall be plenty of unobstructed room for the traffic.

How are these problems to be solved is the question that exercises the minds of the modern road engineer.

The earliest endeavors that were made to meet some of these difficulties consisted in tar-painting or tar-spraying the existing road surfaces, where the road was in good condition. The dust was no doubt greatly diminished, and the surface of the road was in great measure improved and preserved. Since then many hundreds of miles of road surfaces in this country have been thus treated, in most cases satisfactorily, and where there have been failures it has been due to want of proper precautions.

In this connection the Roads Improvement Association has issued a valuable little leaflet, entitled "Notes upon Tar Treatment of Road Surfaces," in which they point out the precautions that should be taken when dealing with the surface of roads in this manner. Shortly their recommendations are:—

(1) It is absolutely necessary that the crust and foundation of the road, taken together, should be sufficiently strong to carry the traffic.

(2) Before treatment the surface should be thoroughly cleansed from dust, caked mud and dung, in order that the tar may adhere properly, and that the surface of the road should be even and without depressions of potholes, etc., before the tar is applied.

(3) No tar should be applied unless the road is thoroughly dug to at least ½ in. below the surface, and they point out how impossible it is for tar to adhere to a wet, or even a damp, surface.

(4) Great care should be exercised in the selection of the tar; crude tar requires special care, as it may contain many detrimental compounds, and they give valuable hints as to the manner in which this may be avoided with reasonable care.

(5) The methods of tar-spraying by hand or machine are not discussed, but it is stated great care should be taken to apply only that quantity which the road will take, and at the same time amply cover the surface; from one-sixth to a quarter of a gallon of tar per square yard is suggested.

The leaflet contains many other valuable recommendations, and I advise all those who are engaged in this description of work to obtain a copy.

There can be no doubt that very excellent results have followed tar-spraying, and it has the advantage of being an exceedingly economical palliative, but it is only a palliative, and only solves the mere fringe of the problem of modern road methods. Something more is required in numberless cases where the traffic has abnormally increased, and a very large number of special methods of construction have been introduced during the last five or six years.

It would be impossible in a short paper to give a list of these various methods; suffice it to say that mainly all of them are on the lines of the introduction of a bituminous material to bind the stones together which form the road, instead of the now old-fashioned method of binding them with sand, dirt and water.

It has been found that the traffic not only wears the surface or crust of the road, but produces a movement among the stones themselves at some depth below the surface, causing a rocking action of the stones and producing an inter-attrition or rubbing which gradually wears off the angles of the stones until they are of a rounded shape and have no interlocking or power to resist movement among themselves. This is the main cause of the excessive mud on an ordinary water-bound road, and it is also the chief cause of the destruction of roads.

It was to meet this interstitial wear, and to confine it, so far as possible, to the upper surface, that the bituminous-bound road has been introduced. The various methods that have been adopted may be divided into the following groups:—

The ordinary water-bound macadam road with surface tarring, or painting, already referred to, and the introduction of various patented preparations to take the place of ordinary tar for this purpose.

Tar-macadam, which consists of broken stones of various sizes, thoroughly dried, then coated with tar or other bituminous mixture (either by machinery or by hand), and then laid in the road and rolled into place.

Tar slag, where slag from blast furnaces is used instead of stone, the tar being applied when the slag is at great heat, thus ensuring penetration.

Tar grouting, where the tar or bituminous mixture is poured on to and into freshly laid dry macadam after it has been laid and rolled.

A modification of the above where special standardized pitch or bituminous mixture is used instead of tar.

A further modification of the above where a layer of very fine "tar concrete" is laid, and dry macadam is spread on the top and rolled into the tar concrete.

A still later development is that of the formation of a "carpet" or covering laid on a foundation or "strength crust" so that the surface or "wearing crust" somewhat resembles a compressed asphalt carriageway.

Each one of the above types of road construction has its merits and supporters; it is difficult, however, to say which of them, if any, will be the ideal road of the future. It is, of course, necessary to bear in mind that first cost of construction, and the life of the road, have an important bearing on the question of what type to adopt, and local considerations must in great measure decide; but so far as our present knowledge on the subject goes, it has become an established fact that the ordinary water-bound road is a thing of the past, and should only be employed where the traffic is light, both in the weights carried and in quantity, or where some special circumstances require that this method of construction should still be adopted. Otherwise modern road methods are undoubtedly in the direction of bituminous roads in some form or other.

The points to be aimed at in modern road construction may be summarized as follows:—

(1) The carriageway should be built on a foundation or "strength crust" of sufficient strength to carry the weight of the traffic and to distribute the pressure of the wheels over the subsoil as to avoid any depressions or subsidences.

(2) Upon this "strength crust" there should be a wearing surface, or crust, so constructed as to minimize the abrasive action of the traffic, and also be quite impervious to water. It is universally agreed that water is even a greater enemy to a road than traffic.

(3) It has been discovered that the traffic not only wears the surface, or crust, of the roads, but also produces a movement among the stones themselves at some depth below the surface, causing a rocking action of these stones, and producing what is known as interattrition or rubbing which gradually wears off the sharp angles of the stones until they are rounded in shape, and thus have no interlocking or power to resist movement among themselves. This is the chief cause of the excessive mud on an ordinary water-bound road, and is also responsible for the ultimate destruction of the road. It has been found that the bituminous mixtures now employed in all modern road making meet this difficulty, and tend to prevent this interstitial wear of the stones by interposing a resilient substance between the stones.

(4) In addition to this, the modern road, constructed with this bituminous binder, gives a slight elasticity or resilient action in the road, and this slight elasticity is very helpful to the present form of traffic. The elasticity of the modern wheel has played a very important part in helping forward the introduction and development of mechanical transport, and a similar elasticity in the surface of the road is equally necessary to preserve the road against the destructive forces of the traffic. It is also eminently desirable that the vehicle using the road should not be subjected to the violent reaction of an improperly constructed road surface. Such reactions must, of course, be detrimental both to the vehicle and to the road. The surface of the modern road should be smooth, and at the same time have a sufficient roughness or "grip" to prevent its being slippery. With care and a selection of the proper method any excessive slipperiness can be eliminated, though so long as horses still use the roads there may be some difficulty in altogether eliminating this objection.

(6) Under modern methods the excessive camber or crossfall of the surface of roads can be greatly reduced. Excessive camber is now altogether unnecessary, and should be avoided, as it tends always to divert the whole of the traffic on to the crown or centre of the road. The camber is only required to throw the water into the channels as speedily as possible, and the smoother the surface the less fall is required to effect this object.

The requisites of a modern road may be summed up as follows:—

It should be sufficiently wide to meet the traffic requirements, but must not be extravagantly costly in its first construction.

The foundation must be sufficiently strong to bear the weight of the traffic, and the surface must be durable, and require the least possible amount of repairs at the least cost.

The road should be safe, firm, hard and at the same time resilient, with an even surface, and yet give sufficient foothold for horses.

It should be as noiseless as possible, and should be incapable of manufacturing any dust or mud. The surface should be so constructed that water cannot penetrate; that cleansing is reduced to a minimum; and that the camber or crossfall should be as flat as possible, compatible with the speedy draining off of the water falling on the surface. There should be no possibility of interstitial movement among the stones of which the road is constructed.

Coal production of South Africa in 1913 was:—Transvaal, 5,225,036 tons; Natal, 2,898,726; Orange Free State, 609,973; Cape Colony, 67,481; total, 8,801,216 tons, an increase of 684,138 tons over the previous year.

If all the capitalization of the various coal mines were added together, including the different C.P.R. mines, the total amount invested would reach the $150,000,000 mark. The annual report of the coal mines branch of the Department of Public Works for the province of Alberta shows that 39 out of the 289 companies operating in the province have a capitalization of $107,450,000. The largest capitalized company in the industry is the Canadian Coal and Coke Company, Limited, which owns four mines—Western Colliery, Beaver Mines; Lethbridge Colliery, Coalhurst; Pacific Pass Colliery, Bickerdike, and St. Albert Colliery, St. Albert. Each of these mines is capitalized at $15,000,000, 4 millions of preferred stock and 11 millions of ordinary stock—the company therefore having a total capitalization of $60,000,000.

A recent statement of the minister of the interior at Ottawa, published in the Canada Gazette, reports that British capital is interested in a petroleum prospect on the Athabasca River, 100 miles north of Edmonton. The statement is to the effect that representations have been made to the minister that certain of the applicants for leases have been negotiating with an influential British company of recognized financial standing for the development of the areas for which they have applied; that final arrangements have not yet been completed, but that there is every prospect of this company being induced to venture a very large sum necessary to thoroughly prospect the district. It is stated that the amount the company is willing to venture is in the neighborhood of $2,000,000.

MUNICIPAL ENGINEERING IN CANADA.

THE young graduate in engineering will find useful the following extracts from a paper presented to the University of Manitoba Engineering Society by Mr. L. M. Jones, City Engineer of Port Arthur, Ont. From a perusal of his observations many suggestions and much enlightenment for the man entering into engineering work may be obtained.

The field of municipal engineering in Canada is broadening more and more every year, due to the rapid growth of the population of our Dominion, the making and revising of our laws relating to sanitary and health matters, and the demands made by the public for up-to-date and modern conveniences which are necessary in making our villages,* towns and cities more attractive places to live in than they have been during the past. Think how many villages have grown into towns and towns into cities during the past decade. The writer ventures to say that traces of the municipal engineer can be found in every one of them, to a greater or less extent. This is only a beginning of what we expect, and the works already constructed are only the commencement of what will be necessary to provide for the future of these towns and cities, and the further constructing and planning of works is practically endless, and must proceed in the same ratio as the growth and expansion, subject, of course, to financial conditions.

To the mind of the writer the field of the municipal engineer is one full of interesting work and study, and probably offers more scope for the development of ability than any other branch of engineering, for the term municipal engineering covers the design of waterworks, sewers, sewage disposal, incinerators, roadways and pavements, street railway, bridges, etc., the supervision and organization required in the maintenance of these works, the collection of garbage, street cleaning, and the works connected with various other public utilities that necessarily form part of the civic organizations which are operated for the welfare of the public. Here, also, one has to do with accounting, cost analysis, municipal and commercial law, assessments, financial matters, and opportunities are afforded, through contact with the public, for studying human nature; for, after all, a good measure of the success of the town or city engineer, in dealing with the public, depends largely upon his knowledge of human nature, and especially is this the case in the smaller places. It is said, and truly enough, that the life of an engineer in charge of the engineering work of a municipality, town or city, is full of trouble and worry. The many causes for these troubles are too numerous to mention here, and while they may appear to come fast and furious, and may appear insurmountable, always bear in mind that your companion of college days, who started out on another branch of engineering, is, no doubt, having his troubles and worries, too. Let me say right here, that no matter who the man is, or whatever occupation he is following, if he is ambitious and has aspirations of some day reaching the topmost rung of the ladder in his chosen profession, his troubles and worries will be commensurate to the amount of work he is properly controlling.

The graduate who has decided to enter municipal engineering life may do so probably as an instrumentman, inspector, or perhaps be more fortunate in securing a position as assistant engineer in some town or city; and it is then that the opportunities for gathering knowledge must be seized upon if success will attend his efforts in the future. Because the college halls have been left is no reason why studies should be abandoned; rather should it be the reason for continuing along the lines where knowledge is required to more intelligently and scientifically carry along the work in hand. During the occupancy of such a position, a full working knowledge, as far as possible, of every department coming under the control of the superior officer should be secured. Ascertain in a general way the methods and organization of other departments coming under the authority of the civic administration. Study municipal law, commercial law, the laws pertaining to contracts, assessments covering the cost of work done as local improvements, the methods of calculating sinking funds, and so on. Keep abreast of the times in town and city planning, sewage disposal and treatment, purification of water supplies, and all other matters which, one might say, may be in a transitory stage. This, of course, can be best done by securing the latest books upon the subject, and finding out what the "other fellow" is doing, through the engineering periodicals. Another thing, and one which will be of great benefit in the future: learn, to a certain extent at least, to speak in public. One of the chief requisites of the municipal engineer is to be able to stand up before his council, which may be surrounded by a gathering of ratepayers, and explain in convincing terms and without losing control, his reasons for doing this thing and that in a certain way. In dealing with the public, cultivate the habit of being master of yourself at all times.

Gradually time moves on, and the graduate of a few years ago has reached the point where he feels capable of taking care of the responsibilities of a position as engineer to a municipal corporation. He receives an appointment, and then it is that he has his first opportunity of taking in hand the whole of the affairs of a civic department. The knowledge previously obtained will be a great benefit and will, no doubt, establish confidence, when properly imparted to others. Besides being engineer, he will become, in a sense, a civic administrator, as the position demands more than engineering alone. Sub-departments have to be established, systems worked out and established, and a hundred and one other things that come and go to make up the duties of the office. In the planning of civic works, don't fail to look far ahead, and plan according to what the probable development will demand in the future. Study out the problems thoroughly, and after a decision is arrived at, make sure the decision is right, stay by it, and see it through. In writing your reports on these decisions, do so as plainly as possible, for remember, you are reporting to laymen, and the simpler and plainer the report the more readily will the contents be grasped. The preparation of these reports may have been long and tedious, causing a vast amount of work. In presenting it to your council it may be turned down. Be not discouraged in this, but bring it up again. Doubtless, your work will be criticized more than that of other public officials, but remember again, that you are the head of the spending department, your department and its work is always in the limelight of civic affairs, and for these reasons criticisms of the engineering work will flow more freely. In this office, opportunities are afforded to meet men of other cities, who are continually negotiating with regard to civic affairs. These men, being of great business ability and broad vision, enable the engineer to establish another viewpoint, and mix the knowledge of business with his knowledge of engineering, and in so doing he is more able to decide wisely upon matters referred to him by his council concerning affairs of the civic administration.

RATING CURRENT METERS.*

By H. O. Brown, B.A.Sc.,
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THE great advances during the past half century in the application of water from the natural streams for water supply, power and irrigation purposes, has led to extensive investigations being made of the flow of water in the different streams throughout the year. Especially in the United States, and of recent years in Canada, under the supervision of the governments of each country, respectively, have these investigations of stream flow been carried on. In this way complete records of the flow of the streams from day to day throughout each year are being obtained.

In Western Canada, where the work in this country was first extensively introduced, a special hydrographic surveys branch was organized under P. M. Sauder, C.E., in 1909. The work was carried on throughout the provinces of Alberta and Saskatchewan, and each year extended so that at the present time discharge measurements and observations are being made of nearly all the streams throughout the provinces.

Since stream measurements were first introduced, various methods have been employed to obtain the discharge or flow of the streams. The first methods were very crude and large errors were possible, but from time to time new and improved methods were introduced. The method of obtaining the stream discharge now almost universally adopted is the "velocity area" method. The area of the cross-section of the stream is obtained by the width of the cross-section being measured and soundings taken at equal intervals in the cross-section, the cross-section thus being divided into smaller sections. The mean velocity of the stream must next be obtained.

The velocity at different points across the stream may be obtained by direct or indirect methods. By the use of floats and float rods, the velocity may be obtained directly, but this method is greatly limited in its application as the necessary conditions of the stream are usually difficult to locate. The velocity of the stream is obtained indirectly by the use of current meters, where a known relation exists between the revolutions of the meter and the velocity of the water. The advantages of the current meter are easily recognized for with it the velocity at any point in the cross-section may be observed and the velocity observations are more easily and accurately obtained.

Since current meters were first introduced in the latter part of the eighteenth century many improvements have taken place. The first type of meter used was that of the float wheel, but this was soon modified to be used beneath the surface. In America patents were taken out as early as 1851. With these early types of meters great difficulty was experienced with the mechanical recording apparatus, due to the excessive friction, but with the introduction in 1860 of an electrical recorder this difficulty was eliminated. Of the many American types of meters which have been constructed, each for use under some special condition, those in most common use are the Price, Haskell and Fteley. The Dominion Irrigation Surveys use the different patterns of the Price meter exclusively, while the United States Geological Surveys have adopted the small Price meter for their work, which has had many improvements in its construction introduced by their engineers from time to time.

Methods of Rating.—Rating a current meter is the determining of the relation existing between the velocity of the moving water and the revolutions of the meter wheel. Theoretically the ratings of all meters of the same make should be the same, but, owing to slight variations in construction, the ratings differ. The accuracy of a discharge measurement depends largely on the accuracy of rating the meter used. Errors of observation are as likely to be too large as too small and are therefore compensating. Errors in a rating table always have the same sign and are cumulative and should therefore be reduced to a minimum.

The method for rating meters now universally employed is that of moving the meter through still water with a known velocity. This method is sub-divided according to whether the meter is suspended from a car or

Fig. 1.

boat, and moved in a straight line or suspended from the end of a long arm and moved in a circular path. The former is called the *linear method*, the latter the *circular method*.

In the linear method the meter is moved through still water along a straight run. A platform is placed by, or over, the water, as the case may be, carrying a track about 200 or 300 feet long, in which the car for carrying the meter is run. The track is laid near the edge of the platform and the meter is suspended in the water from an arm projecting from the side of the car. The car may either be propelled by hand or electrically. Observations of the distance, time and number of revolutions for each run are noted and from these data the revolutions per second and velocity in feet per second are afterwards computed. Many runs are made for each meter, the velocity varying from the least that will cause the meter to revolve to several feet per second. The results of these runs when plotted define the meter rating curve for the meter and from this curve the rating table is computed.

The circular method of meter rating differs from the linear method principally in that the meter is moved in a circular path instead of along a straight path, as mentioned before, the observations taken in each case being practically the same. The meter is suspended from an arm projecting from, and supported by, a vertical centre shaft. The shaft may also be revolved by hand or electrically and a counter shaft with friction pulleys is used to obtain the low velocities. The meter is usually suspended from rods, for reasons stated later, and stay lines are used to keep the meter in place. A circular rating station is dependent upon a linear station for notes by which to

*From the recent report of the Chief Hydrographer, Department of the Interior, on the Progress of Stream Measurements.

adjust the distance of the meter centre from station centre. It has been found by practical test for a small Price meter suspended by rods that the distance is 8.95 feet, for a 60-foot run, or about 0.60 foot less than a 60-foot periphery geometrically requires, which is due to the actuating and resisting forces on a circular tract.

A limited number of comparisons have been made between the circular and linear methods of rating, and it has been found that the circular method of rating cannot be relied upon for rating with the cable, owing to the swinging out of the meter, which introduces an uncertainty in the distance of the run. The ratings on the rod by the circular method agree with the ratings obtained by the other method, as the meter is held firmly in place. It has, however, been found that, owing to the vibration of the car in the linear method, the meter, when suspended on a rod, is retarded somewhat. Therefore, the results of ratings on a cable in this method are being used in preference to those on a rod, even though the meter is used on a rod. While the matter has not been fully investigated, it is believed from the data available that in actual field practice there is no difference between the suspension on a rod and on a cable. The ratings by the circular method on a rod have been found to agree with those by the linear method on a cable, which indicates that in the linear method the rod ratings are affected.

Description of Station and Apparatus.—The current meter rating station of the Department of the Interior, Irrigation Office, at Calgary, Alberta, was constructed early in the season of 1911. It was in operation during the latter part of the open season of the same year and the results obtained proved very satisfactory. At the opening of the season of 1912 the necessary attachments were placed on the car for rating with a cable and a few other improvements made in the apparatus. The station was in operation throughout the whole season until freeze-up and besides rating the meters used by the Dominion Irrigation Surveys several meters were rated for other parties. The following is a brief description of the rating station and apparatus.*

The still water is provided by a concrete tank 250 feet long by six feet wide and five and a half feet deep (inside dimensions), the depth of water in the tank being maintained at about five feet. The track laid along the side of the tank upon which the car is run is of 16-pound steel rails, laid to a gauge of 32⅜ inches on 4-in. x 6-in. ties. Great attention was paid in the laying of the track to have it laid solid and as level as possible with close rail joints (fish plates and bolts being used at every joint) in order that the car should run very smoothly. In the design of the car, which is propelled by hand, the main features have been copied from the car used by the Bureau of Standards, United States Government, at their rating station at Washington, D.C.

The axles of the car run in roller bearings and the frame supporting the front axle with bearings is attached to the platform of the car by a hinge joint. This allows the four wheels of the car to rest upon the track, though it be slightly uneven in places, and makes the level of the platform dependent upon the rear axle. It is thought that this arrangement eliminates all the sharp, vertical movements which might otherwise be transmitted to the current meter in its travel through the water. Two iron arms project from the car to the centre of the concrete tank and these hold the rods, or cable, from which the meter is suspended for rating. Iron arms also project on either side and at right angles to the lower arm for attaching a wire stay line to the meter, when being rated on a cable or small rods. The wheels of the car are solid castings and all the steel in the car is of heavy section, it being easier to maintain a uniform rate of travel with a heavy car than with a light one.

The diagram (Fig. 2) represents the electrical connections used for the recording apparatus at the rating station. As stated before, observations of the distance, time and number of revolutions for each run must be taken. The run is of a fixed distance of 200 feet (25 feet being left at each end for starting and stopping the car), therefore the number of revolutions and the time of the run only have to be observed. The time of the run is recorded automatically by an electro magnet operating a stop watch. A switch is placed at each end of the run and the car in passing over each closes the electric circuit in which the stop watch electro magnet is connected. This causes the steel core to be drawn up into the solenoid by magnetic force and a lever fastened to the end of the core pushes on the stop watch stem. At the beginning of the run the watch is thus started by the car closing the first switch and stopped at the end of the run when the other switch is closed. The double throw switch is used to throw three extra cells into the circuit by moving the blade over, as shown, when the switch at the *out* end of the run is to operate, for here the resistance of the circuit is increased. This arrangement prevents the watch from being struck too hard a blow by nine cells being in the circuit instead of six, as required for the switch being operated at the *in* end.

The revolutions of the meter for each run are also automatically recorded by an electric recorder arranged in circuit with the meter, as shown in the diagram. The circuit for recording the revolutions of the meter is ready to be closed by the contact in the meter head, when a switch on the car is thrown in, as the starting post is reached. The meter continues to record until the end of the run is reached and then the circuit is again broken by a switch on the car being opened as the end post is reached.

As the meter seldom records exactly at the beginning and end of each run a small error is introduced in taking the recorded revolutions as the revolutions for the time of the run. For this reason the writer adopted the following method of obtaining the data for more accurate calculations of the revolutions per second of the meter for each run.

When the car has passed the starting post, when a run is being made, as the first contact of the meter is recorded a separate stop watch is started, independent of the watch recording the time of the run. The first time the meter wheel records may be a few feet past the starting post, but the time for this unknown part of a revolution of the meter over this distance has not been recorded either. The number of revolutions of the meter after the watch has been started is observed until the meter is almost at the end of the run when the stop watch is again stopped at the end of a complete revolution of the meter as recorded. Thus the time for an exact number of revolutions of the meter and this exact number of revolutions of the meter have been observed for the run, and from these data it is seen that the revolutions per second are more accurately calculated. In this way the error pointed out above was greatly eliminated and better defined rating curves were obtained.

Rating Meters.—The method of suspension employed in the rating of the meter depends upon the type of meter.

*For a full description of this station the reader is referred to *The Canadian Engineer* for October 24, 1912.

For the reasons mentioned before, all the meters that can be suspended from a cable are rated thus, but the meters designed for use on rods only necessarily have to be rated upon the rods. When the meter is suspended by a cable, it is fastened to the upper part of a hanger to which the cable is attached and the meter in this position is free to tilt up or down. The lead weight (for large meters, 15 pounds, and for small meters, 13 pounds) to keep the meter in position in the water is fastened below the meter upon the hanger. The stay line is fastened to the top of the hanger and to the end of the arm on the car for this purpose and facing the direction in which the run is to be made. The suspension cable used is an electric cable which is about a quarter inch thick. This cable avoids the use of an extra cable for the electric circuit and is also used upon the meters in the field. It is passed through the loop in the lower arm projecting from the car and fastened to a swivel on the upper arm. The length of the suspension cable is just sufficient to allow the meter to hang about two feet below the surface of the water and by means of the swivel the meter is easily faced in the proper direction. Care must be taken to see that the meter rests horizontally and parallel to the direction of the run and that the electric wires connected to the meter will not cause the meter to alter its position when in motion or interfere with the meter wheel.

some distance back from the starting point, that the meter wheel may reach the corresponding revolutions per second. After the first run has been obtained the velocities for the following runs are increased by a half foot per second, respectively, as nearly as possible, so as to give points for the rating curve which will be uniformly distributed.

For each run, as stated before, the time is automatically recorded and the length of the run being 200 feet, the velocity in feet per second is computed from these data. Also, the time of a certain number of revolutions of the meter wheel having been observed for each run, the corresponding revolutions per second are computed and these results being plotted with revolutions per second and velocity in feet per second as co-ordinates locate the points which define the rating curve.

The rating curves are plotted on cross-section paper, the scales used being: five centimetres equal to 0.5 revolutions per second on the "Y" axis for high and low velocities and five centimetres equal to 1.0 foot per second on the "X" axis for high velocities, with five centimetres equal to 0.5 foot per second for the low velocity curve. When two curves are drawn separately for the high and low velocities, respectively, the rating curve usually consists of two straight lines, the break occurring very close to a velocity of 2.00 feet per second. Theoretically there is no pronounced break in the rating curve at this point, but, owing to the fact that the curvature is so decidedly small both above and below this point, it was decided to draw the curve as two straight lines. When plotting the curve the high velocity curve is usually drawn first and the point of revolutions per second corresponding to the velocity of 2.00 feet per second is transferred to the low velocity scale and the low velocity curve drawn from this point downward.

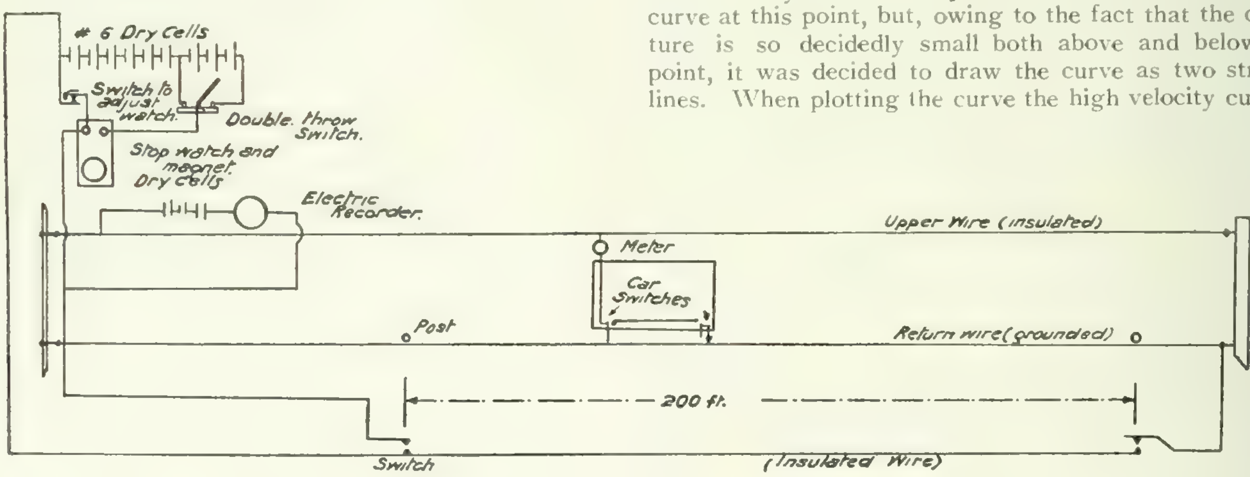

Fig. 2.

When the meter is suspended from rods, it is, as mentioned before, placed about two feet below the water surface. The rods are firmly held in the arms projecting from the car and very light waterproof electric cable is fastened to the meter for the electric recording circuit. A stay line is also fastened to the meter, when the rods used are light enough to bend when the high velocity runs are being made.

The meters are usually rated first in the condition in which they have been sent in from the field and then, if necessary, are thoroughly cleaned, fitted with a new bearing, properly adjusted and oiled and rated again. In all cases it is necessary to see that the commutator in the meter head is adjusted to give a good contact to properly operate the electric recorder, which will not operate with as small an electric current as the telephone recorder used in the field.

In rating the meter several runs are made, usually about twenty, with velocities varying from the least that will cause the meter to revolve to about ten feet per second. It is very essential that the velocity for each run be uniform throughout and that this velocity be attained

On each separate rating curve sheet for each meter, besides the rating curves for that meter, is placed the standard rating curve for that type of meter. This curve is used as a comparison for the other rating curves of the meter, and these rating curves, being placed together on the same sheet, the general behavior of the meter from rating to rating may be observed.

Construction of the Rating Tables.—If the rating of a meter comes within one or two per cent. of the "standard" curve for this type of meter then the standard table is accepted for this meter. If the rating shows a greater difference than this then an individual table is constructed from the rating curve.

Two general forms of rating table are in use: one which gives the velocity to the nearest 0.01 foot per second corresponding to each 0.01 revolution per second from 0.0 to that corresponding to the highest velocity, for which the meter shall be used; and another form which

gives the velocity to the nearest 0.01 foot per second corresponding to a certain number of revolutions in a certain number of seconds. The number of revolutions for this latter form of rating table is 5, 10, 20, 30, etc., and the time period being 30 to 60 seconds or 40 to 70 seconds. During the past season both these general forms were made out for each meter by the Department of the Interior, but it is intended to adopt the Revolution-Time form. The 40 to 70-second form of the Revolution-Time table has been used because of the lower velocities given and also the time of an observation being necessarily increased, but it also has the slight disadvantage that the velocities do not increase continuously between the 5, 10 and 20-revolution columns as in the 30 to 60-second table.

The Revolutions per Second-Velocity per Second table is constructed from the rating curve by reading the V.P.S. corresponding to each .05 R.P.S. and then filling in velocities corresponding to each .01 R.P.S. by dividing the differences evenly. The rating table of the second form gives the equivalent R.P.S. for the number of revolutions for each second of time between 40 and 70, so in constructing the table of this form, observations are taken from the curve of the velocities corresponding to each five seconds of time throughout the table. The differences in this form cannot be divided evenly between these points because the R.P.S. do not increase uniformly, so the differences must be divided proportionally to the increase of R.P.S. When the table of the first form is constructed first, the greater part of the table of the second form can be filled in from it and thus reduce the number of calculations.

One disadvantage given by engineers for the table of the second form is that it is necessary to interpolate to obtain the velocity, when the time of the observation is observed to the fifth of a second. For the low revolution columns it is not necessary to interpolate if the time is observed to the nearest half second, as the velocity increase is small, but in the columns from twenty revolutions upwards the velocity differences increase rapidly. The time being observed to the fifth of a second it seems, to the writer, that tables made out for each fifth second would be very helpful. These could be constructed by the engineer from the present form of rating table for velocities between the limits in his work.

It has been decided that the 1914 Forestry Convention is to be held in Halifax, and the date definitely decided upon is from September 2 to 4, 1914.

According to the Rheinasch-Westfalische Zeitung, of Essen (Ruhr), a new process for ridding boilers of troublesome scale has been adopted, which promises to become of universal use, it being to date the only practicable process for this sort of work. The method consists of passing an oxy-acetylene flame over the scale, which will be removed in large sections, with the wall of the boiler remaining cool during the operation.

The Shipshaw Water Power Co., which is being developed by Price Brothers and Co., is located on the Shipshaw River, at Murdoch Falls, about two miles from Kenogami. The present installation of the company consists of two 3,000 h.p. units. It is intended to develop at first about 5,000 h.p., which amount has been contracted for by Price Brothers and Co., at $15 per h.p. This will give gross earnings of $75,000.

A report has been published at Berlin, Germany, to the effect that the Schleswig-Holstein Government has ordered that steps be taken preliminary to the construction of a canal between Eckernforde and the Kaiser Wilhelm Canal, of a canal between the broad part of the Schlei and Eckernforde, and of a harbor at Eckernforde. This indicates the probable consummation of a long-considered plan for a second outlet from the Kaiser Wilhelm Canal to the Baltic, which would be chiefly of military value.

A SHORT METHOD OF THE STADIA.

By John H. Curzon.

FOR a great many purposes the common method of stadia surveying is too laborious and not quick in either the field or office. Especially is this true in the case of a rough topographical survey which takes almost as much time as a more accurate one would require, while the time expended in figuring and plotting the survey is greater than the time required for the actual field work. The method herein described is quite accurate enough for landscape engineering and may be used to good advantage in a great many ways, for which heretofore the usual practice has been considered too arduous for the result to be obtained. The author has used this method to very good advantage in rough prairie work in the West and has found that when one becomes practised it can be made a great time saver.

For the horizontal angles the same method as for the regular stadia is employed, viz., both A and B verniers are read and noted.

No record is kept of the vertical angles. The elevations are found by "rod intervals." Suppose the instrument to be set up at a point A and values are known of the height of the instrument (H.I.) above the point and also of the elevation of the instrument above datum (E.I.). This is generally assumed, e.g., E.I. is 129.67 and H.I. is 5.32, whence the elevation of the station is found to be 129.67 — 5.32 = 124.35.

Then, suppose the instrument is sighted on some point, B, with the telescope clamped level and read 4.28 with middle wire and 3.00 and 5.56 with lower and upper wires respectively. Then the elevation of point, B, would be, as in direct levelling, 129.67 — 4.28 = 125.39, and the distance approximately 5.56 — 3.00 = 256 ft.

No account is taken of "f + c" as in ordinary topographical surveying. Distances to intermediate points are close enough to be read directly off the rod.

Now, suppose the rodman moves on the same radial line to a point C, which is above the middle wire of the telescope when clamped level. The method of procedure is then as follows: With the instrument clamped level take a sight on some point which is in line with the upper cross-hair such as a bush or stone (or point on the rod) which is easily visible. Without taking the eye away from the telescope use the slow-motion screw to raise the telescope until the lower cross-hair cuts the bush or point just where the upper cross-hair cut before. If you do not yet hit the rod with the middle hair, proceed as before and turn the telescope through another interval, sighting the top hair on a bush or other object as before. Now the middle wire reads 6.84, the upper wire reads 10.06 and the lower wire reads 3.62. Then the rod interval is 10.06 — 3.62 = 6.44 and the distance is approximately 644 ft.

As for the elevation, the E.I. is 129.67 and the telescope has been through three "rod intervals" of 6.44 and read 6.84, therefore the elevation of point C is 129.67 + (3 × 6.44) — 6.84 = 142.15.

If the instrument has now to be moved up to point C, after setting, measure the H.I. and find the E.I. For example, 142.15 + 5.02 = 147.17 is the new E.I., when set up at point C. Make the B vernier read the same as the A vernier read when sighting on C from A. To check the difference in elevation of points A and C, level the telescope, sight with low wire on some point in the distance and depress the telescope until the upper wire

strikes the point sighted on previously by the lower wire. Then proceed until the rod is hit with the middle wire. Supposing it has been a drop through two intervals and the reading is 8.80 with the middle wire, and 12.13 and 5.47 respectively with the upper and lower wires. Then the interval is 6.46 and the distance, 646 ft. Previously the distance was found to be 644 ft.; therefore, average is 645 ft., which is the corrected distance. The elevation of point is now found to be $147.17 - (2 \times 6.46 + 8.80) = 124.45$, whereas it was previously 124.35. Therefore the mean elevation is 124.40 and the corrected Elevation of Instrument is $147.17 - .05 = 147.12$.

When the E.I. is corrected in this manner it is customary to distinguish it in the notebook by drawing a circle around the figures. The headings for the form of notes in the field book are as follows:

Sta.	A	B	Dist.	Rod	Elev.	E.I.

The right-hand page is reserved for sketching and remarks.

The author is fully aware that many errors are introduced by this method but offers no apologies for it whatever for its use in rough survey work.

IMPROVEMENT OF MONTREAL HARBOR.

THE Harbor Commissioners of Montreal have commenced preliminary operations in connection with the harbor improvement to be carried out this season, and in a short time the full program of work, involving an expenditure of approximately $3,000,000, will be under way. It will be a continuation of the improvements already begun, and will include the completion of the 20-foot channel to divert part of the St. Mary's current.

The electrification of the high-level railway will be commenced and the railway itself may be extended, including the construction of several bridges, for a distance of about 4 miles to Pointe aux Trembles, where the construction of the new wharf for the Canada Cement Company will shortly be commenced.

At the site of the dry dock dredging will be continued and the quay walls raised for approximately 800 ft. of length.

It is probable that the new wharf for the Armstrong-Whitworth Company at Longueuil will be constructed this year, while on the Montreal side of the river, work will be carried on in connection with the new Victoria pier, which is already about half completed.

Dredging is to be continued throughout the harbor and ship channel, the dredging of the latter to be carried on by the Government, it being outside the jurisdiction of the Harbor Commission. It is understood, however, that the Commissioner's dredges will assist on this work.

The 20-foot channel mentioned above in connection with St. Mary's current, the dredging of which will constitute one of the most important of the harbor works this year, has for its object increase of the flow of water outside the islands, thus diminishing the current in the harbor and making it more suitable for shipping. Last season the channel was completed for a short distance from the south end and a noticeable improvement was the result. This year dredging will progress from both ends of the channel, and it is expected that the work will be completed before fall.

CONSOLIDATION OF ENGINEERING SOCIETIES.

AT the annual meeting of the American Institute of Electrical Engineers a paper was read and discussion took place on the subject of combining the membership, or parts thereof, of the national engineering societies of the United States in one association. The primary object might be sufficiently and plainly described as "to foster and develop the human factor in the engineering profession, to place the engineer on the same plane as the lawyer and doctor," "for the discussion on engineering in general . . . except scientific and technical subjects . . ."

There was no adverse discussion and both paper and discussion show that even the leading members of the great national societies whose objects are to advance science and engineering realize that something more is needed. What they realize may be stated in this way:

(1) An organization separate from those of a scientific character is essential to develop the standing of the engineer as a social unit.

(2) There is no "adjectival" distinction between engineers when their interests in society are to be protected or advanced. At such a time architectural, civil, electrical, mechanical and mining men stand as a unit.

It will probably take much time to develop a scheme which will appeal to the members of four or five different bodies so large in numbers and pregnant with tradition as these national engineering societies, but in the meantime it cannot fail to be of interest to the profession at large to know that younger bodies are leaving the slow and heavy methods of debates to their elders.

An important consolidation of societies has just been effected by an order of the Supreme Court of the State of New York which has merged the Technical League of Engineers and the American Society of Engineer Draftsmen, both incorporated bodies, into a new organization to be known as the Technical League of America. The name was adopted because it includes architecture and every branch of engineering as well as every grade of worker in all those branches from engineer-in-chief to tracer or technical student.

These two societies, though comparatively young, have done good work; the Technical League of Engineers among civil service departments, and the American Society of Engineer Draftsmen in commercial fields.

This consolidation is the result of a thorough and comprehensive study of every phase of the question of placing the engineering profession on a higher social plane and obtaining for the engineer and his assistants that recognition, both economic and social, which is due to men through whose untiring efforts almost every possible safeguard for human health and every device for the higher development of the human race is conceived.

The experiences of the two organizations were analyzed; the tenor of opinions expressed in the technical press were studied and weighed together with papers, discussions and addresses made before other engineering societies. Committees of these two progressive bodies came together and after careful consideration of all of the facts endorsed the following significant pronouncement: In advancing the economic and social status of the engineer, no discrimination can be exercised:

Against any branch of architecture or engineering or any subdivision thereof.

Against any grade of engineer or assistant which the necessities of the profession has brought or may bring into existence.

On account of geographical location.

WATERPROOFING OF MASONRY AND BRIDGE FLOORS.

THE following is the final report of the committee, on waterproofing materials and methods of the American Railway Engineering Association, with respect to the waterproofing of masonry and bridge floors. This report, presented at the recent convention in Chicago, is regarded as a very satisfactory and valuable summary of established practices. From it the following notes are taken:—

Structures should be waterproof when it is necessary: (1) To prevent dampness in walls above grade, and in walls and floors below grade. (2) To prevent flooding of basements and pits, which are at all times or occasionally below the ground water level. (3) To prevent percolation or leakage of water through the masonry and the formation of unsightly deposits on exposed surfaces. (4) To prevent the dripping of water through a bridge floor over a street, and in the cases of solid floors of steel or reinforced concrete bridges, to protect the steel from corrosion. (5) To prevent the entrance of water into tunnels, either above or below ground water level, or subaqueous tunnels. (6) To prevent leakage from reservoirs. (7) To prevent the penetration of water into the masonry.

The following outline includes the ordinary methods of waterproofing:—

(I.) Coatings: (1)Linseed oil paints and varnishes. (2) Bituminous: Asphalt coal tar. (3) Liquid hydrocarbons. (4) Miscellaneous compounds. (5) Cement mortar.

(II.) Membranes: Felts and burlaps in combination with various cementing compounds.

(III.) Integrals: (1) Inert fillers. (2) Active fillers.

(IV.) Watertight concrete construction.

Walls above grade are waterproofed by coating with paints, varnishes, or waterproofing washes, or by plastering with cement mortar. The coating or plaster may be applied either on the inside or outside of the wall.

The walls of basements and pits are waterproofed, either by the application of coatings, membranes, integral or watertight concrete construction. Membranes are usually protected with concrete, brick or bituminous binder.

Where basement or pit walls and floors are below the ground water level, they must be so designed as to resist the existing hydrostatic head in order to prevent cracks and leakage. Such walls may be waterproofed by the integral method or by watertight concrete construction. When exterior waterproofing is employed, the membrane method is generally used properly protected.

Stone, brick or concrete arches, retaining walls, abutments, subway walls and culverts are waterproofed by any of the methods mentioned in the preceding paragraph. For important structures, the membrane method is most generally used.

When surface coatings, integral waterproofing or watertight construction is used, particular attention must be paid to reinforce the work against cracks due to expansion, contraction or settlement. The expansion joints must be waterproofed by sheet copper or lead built into the adjoining sections.

The solid floors of steel and reinforced concrete bridges probably present the most difficult problems of waterproofing. In steel troughs or I-beam floors a concrete filling may be used to bring the deck up level with, or above the top of the steel in the floor. The floors of this class of structure are usually waterproofed by the membrane method.

Tunnels in which the ground water level is below the invert may be waterproofed by any of the aforementioned methods.

Subaqueous tunnels present a different and distinct problem of waterproofing; usually reinforced concrete, or plain concrete, with iron or steel lining is used. The structures are designed to resist the hydrostatic head.

The walls and floors of reservoirs may be waterproofed by any of the four methods before mentioned.

Coatings.—Linseed Oil Paints and Varnishes.—Linseed oil paints and all coatings containing linseed oil are reactive to atmospheric conditions and to alkaline water. Applied as a damp-proofing to the surface of a concrete wall which may be permeable to moisture, the paint is likely to be of short life unless the surface is specially prepared. To secure the best results, the wall must be dry and clean before application. The paint is applied with a brush in the ordinary manner. The coating power of paint is approximately 200 sq. ft. of wall per gallon of paint, but varies with the thickness of the paint and the nature of the surface. The prices of the paints sold for damp-proofing masonry and concrete surfaces carry from about $1 to $3 per gallon for the material.

Bituminous Coatings.—This class includes asphalt, petroleum residiuum, coal tar and coal tar pitch. As used for waterproofing purposes, they are solid at ordinary temperatures, and are, therefore, often applied while hot. As they are soluble in benzine and coal tar naphtha, they are frequently mixed with these solvents and applied in a liquid form. Two coats cost about 1 ct. for material and ¼ ct. for labor per square foot.

Asphalt.—Waterproofing by the application of liquefied asphalt, as a paint applied with a brush or mop, has been used on practically all kinds of engineering structures as a surface coating.

Bituminous coatings applied cold by dissolving in naphtha, instead of hot, do not set instantly, therefore are much easier to apply. The work can be done by an ordinary laborer, care rather than skill being required in its handling. All walls that are to be waterproofed must first be allowed to dry.

If the waterproofing is made by dissolving the bitumens in a volatile solvent with a dryer so that it may be applied cold like a paint, it is difficult, if not impossible, to prepare a paint that will dry to the right consistency and then stop. The usual result is that the drying and hardening continues until it reaches a point where its waterproofing qualities are destroyed.

Hot asphalt will not adhere to cold, damp concrete. Several different methods of heating the surface of the concrete have been used. Gasoline has been poured over the surface and burned; hot sand has been spread over the surface and swept back as the waterproofing proceeds. It is claimed, however, that heating the surface draws up moisture and prevents the asphalt from adhering. It is necessary that the concrete be thoroughly dry before the asphalt mixture is laid upon it, as the steam caused by placing the hot material upon a damp foundation will prevent adhesion. Good results have been obtained by first painting the surface to be treated with a priming coat of asphalt cut with naphtha or benzine and then applying the hot asphalt over this coat.

In applying hot asphalt directly to steel, difficulty is found in getting the asphalt to adhere to the steel, and no dependence can be placed upon adhesion to vertical surfaces.

The asphalt should be heated in a suitable kettle to a temperature not exceeding that allowed in the specifications for any particular structure depending upon the

material used. If this temperature is exceeded, it may result in pitching the asphalt. Before the pitching point is reached, the vapor from the kettle is of a bluish tinge, which changes to a yellowish tinge after the danger point is exceeded. The asphalt has been cooked sufficiently when a piece of wood can be put in and withdrawn without the asphalt clinging to it. Care should always be taken not to prolong the heat to such an extent as to pitch the asphalt. Should it become necessary to hold the heated asphalt for any length of time, the fire should be drawn or banked and a quantity of fresh asphalt should be introduced into the kettle to reduce the temperature. Excessive heat converts the petroline or cementitious constituents of the asphalt into asphaltene, which is devoid of cementing properties, and by so much reduces the cementing quality—the vital element—of the asphalt. The fire should not be allowed to come into direct contact with the melting kettle or tank. Asphalt coatings cost about 65 cts. per gallon for material and 3/10 ct. for labor per square foot, a gallon covering about 100 sq. ft. per coat.

Asphalt Mastic.—Various results have been obtained by the use of asphalt mastic, and it is probable that much is dependent upon the quality of the mastic. The requirements of a sand for asphalt mastic are much the same as those for cement mortar. It is common practice to mix a certain amount of limestone screenings with the sand, with the intention of securing an aggregate with the least percentage of voids. The strength and compactness of the mastic will depend considerably upon the percentage of voids, and the proportion of asphalt used in the mastic should be sufficient to fill the voids and completely coat each particle of sand and screenings. Too much asphalt will produce a mastic that is soft and easily indented, does not offer a good protection against the ballast on a bridge floor, and flows more readily than a well-proportioned mixture.

The asphalt and sand are separately heated to from 325 to 350°. The proper proportions are measured out simultaneously, poured into a mixing vessel and thoroughly mixed. The operation of mixing the asphalt mastic requires care in heating the ingredients to secure uniform temperature, not to overheat the asphalt, to proportion the mixture accurately, and to mix the materials thoroughly. The mixture is dumped in place and spread evenly over the surface with wooden floats, shovels or rakes. After being compressed with tampers, the surface is finished with hot smoothing irons.

Asphalt mastics are usually applied in layers not exceeding ⅝ in. in thickness. Usually two coats are applied, the coats to break joints not less than one foot. The cost of asphaltic mastic 1¼ in. thick is about $30 for material per net ton, a ton covering about 375 sq. ft.; the cost of labor is about 2 to 5 cts. per square foot, depending upon location and conditions.

Coal Tar and Coal Tar Pitch.—Tar produced by the distillation of bituminous coal is used in waterproofing, either applied cold as a paint by dissolving in naphtha or benzine or applied hot. It is also mixed with sand, gravel or screenings to form a mastic. It is generally found to be difficult to obtain coal tar of good quality. Good coal tar compares favorably with asphalt as a waterproofing material. The present price of coal tar pitch used for waterproofing is about $17.50 per net ton.

Coal Tar Paint.—Annapolis mixture is a coal tar paint composed of 1 part kerosene oil, 4 parts Portland cement and 16 parts refined coal tar. The mixture is put on with a paint brush in the same way as ordinary paint is applied. The compound not only covers the surface, but sinks into and bonds with it, so that two or three coats are sometimes required. It has been found to adhere to moist or even wet concrete. The cost for three coats is about ½ ct. for material and about ½ ct. for labor per square foot.

Liquid Hydrocarbons—Paraffin and Petroleum.—Waterproofing by the application of a coating of melted paraffin has been used on masonry in much the same manner as hot asphalt. Paraffin is also applied cold as a paint made by dissolving the paraffin with naphtha. Petroleum oil is sometimes applied to the surface of masonry as waterproofing. The efficiency of these materials depends upon their absorption into the surface of the masonry. Applied to clean, dry surfaces of porous masonry, they are fairly efficient as damp-proofing.

Soap Washes.—Solutions of soap applied as a wash for waterproofing or damp-proofing masonry surfaces are not recommended, as no permanent waterproofing effect can be depended upon.

Soap and Alum Washes.—Waterproofing by alternate washes of soap and alum is one of the oldest methods of treating masonry surfaces, and has given fair results when properly used on surfaces sufficiently dense and impermeable to afford support for the void-filling material. Inferior materials and workmanship cannot be atoned for by the use of alum and soap washes. The alum and soap combine and form an insoluble non-absorptive compound in the pores of the masonry surface. The cost of applying two coats each of soap and alum washes is about ½ ct. per square foot of surface.

Cement Mortar.—The method of waterproofing masonry structures by the application of a plaster coat has proved efficient when the plaster has been properly applied. The surface to be waterproofed must be clean to insure bond between plaster and masonry. Old surfaces may be cleaned by chipping off a thin layer from the face or by the use of a sand blast or steam jet. The surface must then be kept wet until it has absorbed water to its full capacity. A wash of neat cement mortar should then be applied with a brush. This wash should be mixed to the consistency of cream and should never be used after it is 45 minutes old. The plaster should be applied over the cement wash before the latter has commenced to dry. The sand to be used in the mortar should receive careful attention. It should be well graded from fine to coarse, the maximum size of particles being that passing a No. 8 sieve. Portland cement and sand should be mixed in the proportion of 1:1½. The mortar should be applied in layers about ⅜ of an inch thick if more than one coat is used. Each coat should be applied before the preceding one has attained its final set. Good workmanship is essential and the use of a wooden float is necessary in order to obtain a dense, impermeable coating. As ordinarily applied, the finished coating is about ¾ of an inch thick. The cost of ¾-in. plaster, applied as above, will be about 6 cts. per square foot.

Membranes.—Membrane waterproofing consists of the formation of a mat or covering of waterproofing material over the surface to be waterproofed, made up of a number of layers of membrane united by a cementing material. Being somewhat elastic and independent of the movement of the surface, this method offers a protection from the seepage of water through expansion or contraction joints and cracks in the masonry which cannot be secured by any other. For this reason it is largely used for waterproofing subways, arches, solid floor bridges, retaining walls, basements, pits, etc. It is also largely used in important structures in connection with some integral form of waterproofing as a precaution

against seepage of water through cavities that may occur in the masonry.

Although waterproofing by the membrane method has been unsuccessful in many cases and many reports of failures are returned by the railroad companies, the better methods of membrane waterproofing now in use are giving excellent results. The character of the structure is frequently the greatest drawback to the life of the waterproofing. The greater the number of projections and irregularities in the surface to be waterproofed, the more the liability of leaks. Many times the design of the structure is such as to make it impracticable to waterproof in a permanent manner. Sudden slopes or deep drops between the different elevations of the floor often cause the protection to slide, with a consequent tearing of the waterproofing. Often on railroad bridge floors the waterproofing is destroyed by the creeping of its protection under traffic; on arches or sharply inclined surfaces by its movement due to the settlement of the fill. In many cases the labor employed is quite unskilled and the results are obviously poor. Another factor in the success or failure of waterproofing is the state of the weather. In cold weather the heated materials cool too rapidly. In very damp or rainy weather it is impracticable to make a good job of waterproofing, unless some protection from the weather is provided. Other causes of failure are the lack of free working space and interruption by traffic. Any of these causes may lead to failure, even with the best materials.

Materials.—The materials of membrane waterproofing and the combinations that have been used most successfully by the various railroads are as follows:—

Wool felt impregnated with either asphalt or coal tar pitch.

Wool felt impregnated with either asphalt or coal tar pitch and skin-coated with the same material.

Wool felt impregnated with coal tar pitch and reinforced with a thickness of cotton drilling cemented to the felt with coal tar pitch.

Asbestos felt impregnated with asphalt.

Burlap, both plain and impregnated with either coal tar pitch or asphalt.

Mined or lake asphalts.

Petroleum asphalts.

Coal tar pitch.

Two to three layers of felt cemented together, used generally for damp-proofing and for the backs of retaining walls or foundations where no provision for a head of water is necessary.

Four to six layers of felt cemented together, used generally for railroad bridge floors, arches, tunnels subways and for a protection from a head of water.

To add tensile strength to the waterproofing, the following combinations are commonly used:—

One middle layer of reinforced felt or burlap and four layers of felt, all cemented together.

One layer of felt, two layers of burlap and two layers of felt cemented together.

Three layers of burlap and one top layer of felt cemented together.

Combinations of coal tar pitch and asphalt-treated felt or asphalt and coal tar-treated felt should not be used as the materials will not combine.

In using burlap it is recommended that burlap impregnated with either asphalt or coal tar pitch be used, otherwise, owing to its nature, it is impracticable to prevent the absorption of moisture when the material is exposed to the weather. Moisture promotes rot and also greatly reduces, or, if present in any quantity, prevents the bond of the hot cementing material and its penetration of the pores of the burlap. On the other hand, the treating of burlap promotes the bond and penetration as the treating materials in the burlap are softened on the application of the hot cementing material, and the whole becomes united in one mass.

The use of burlap with cementing material, whose temperature on application exceeds 450° F., is not recommended, as the higher temperatures are likely to result in burning and destruction of the burlap.

In many cases it is desirable to bond the waterproofing to the surface. This is not desirable in the vicinity of expansion joints or where there is likely to be a movement of the surface. At such points special provision must be made in the waterproofing to allow for expansion.

Protection.—To protect the membrane from injury it is necessary to provide a covering of some hard material that cannot be penetrated by ballast, tamping picks nor by sharp stones. Of the various methods, the following three have been the most widely used:—

(1) Brick laid flat in the hot cementing material with joints poured with the same material, or brick laid in cement mortar. On comparatively flat surfaces, brick is practicable with a bituminous binder, but on steep surfaces or slopes, the tendency to creep in hot weather makes it unsuitable. One great advantage of brick is that it can be laid quickly and easily under traffic. Brick, if used on large areas or on the extrados of an arch or on steep slopes, should be laid in cement mortar to prevent creeping.

(2) A cement mortar coating about 2 ins. thick, reinforced with wire mesh, forms a good protection and can often be used to better advantage where there is a tendency of the protecting materials to creep. This protection is recommended for arches and tunnels.

(3) A bituminous binder not less than 1¼ ins. thick, consisting of asphalt or pitch mixed with sand, gravel or fine crushed stone and applied over the waterproofing, has often been successfully used. If this is used, it should be of such consistency in hot weather as to prevent runs and the stones forcing through the protection to the waterproofing. It is not recommended on steep slopes.

Specifications.—The following specifications for five-ply waterproofing is typical of those in use by the various railroads, and applies equally well to combinations of felts and burlaps or felts and reinforced felts:

The surface on which the waterproofing is to be applied shall be dry and free from all sharp projections or irregularities of any character other than those shown on plans.

If it is desired to secure the waterproofing to the surface this surface shall be given one coat of hot cementing material mopped on uniformly, which coating shall be thin enough to penetrate the recesses, and in the case of concrete, to form a bond for the subsequent waterproofing coating. In order to insure the adhering of this coating it is advisable, in cold weather, to first heat the surface with hot sand, which is to be swept off as the cementing material is applied, or a priming coat of the cold cementing material which has been thinned with a suitable solvent may be applied.

On this first coat shall be applied a heavy coating of hot cementing material, into which shall be laid, shingle fashion, two layers of felt lapped one-half the width of the felt and cemented together with cementing material. The surfaces of the two-ply felt thus formed shall be mopped uniformly with hot cementing material and followed with three layers of felt laid shingle fashion

in this material and lapped two-thirds of its width. The surface of the five-ply felt thus formed shall be given one heavy coat of cementing material, making a five-ply waterproofing membrane all thoroughly saturated, cemented and bonded together.

In the courses thus built up it is important to have the moppings of cementing material uniform, so that felt shall not touch felt at any point and to insure a surface free from all folds and pockets.

At girder webs or around gusset plates, corners, or over column connections and expansion joins, the waterproofing membrane shall be reinforced with at least two thicknesses of felt.

Over the surface of the membrane shall be placed a protection of either brick, bituminous binder or concrete, plain or reinforced.

Cost.—Cost of membrane waterproofing varies greatly with conditions. A five-ply membrane waterproofing, with asphalt-treated felts cemented with asphalt, will cost from 25 cts. to 45 cts. per square foot, including a bituminous binder or brick protection and labor. A five-ply membrane waterproofing, using four layers of coal tar pitch-treated felt and one layer of felt reinforced with cotton drilling, cemented with coal tar pitch, will cost from 20 cts. to 35 cts. per square foot, including bituminous binder or brick protection and labor. A four-ply membrane waterproofing, using one layer of asbestos felt and three layers of impregnated burlap cemented with asphalt, including 1¼-in. thick asphalt mastic protection and labor, will cost from 20 cts. to 30 cts. per square foot; cost of asphalt about $30 per gross ton; cost of coal tar pitch about $17.50 per gross ton; cost of asphalt-treated felts from $1 to $1.25 per 100 sq. ft.; cost of coal tar pitch-treated felts about 25 cts. per 100 sq. ft.; cost of reinforced felt from $2 to $2.25 per 100 sq. ft.; cost of asbestos felt about 70 cts. per 100 sq. ft.; cost of brick $8 to 12 per thousand.

Integrals.—The use of some material in small quantities, mixed with the concrete materials in order to make concrete watertight, is generally called the integral method of waterproofing.

Inert Fillers.—The addition of a small amount of fine material to a rich concrete mixture with a well-graded aggregate, decreases the strength of the concrete. The effect upon leaner mixtures is to increase the impermeability of the concrete without decreasing its strength. Fillers used should not only be inert toward the action of the cement, but also to atmospheric conditions and to water. Material containing organic matter should be avoided, owing to its deleterious effect upon the strength of the concrete.

In using inert fillers in mixing concrete only such materials should be used as have been thoroughly analyzed as to their chemical properties and effect upon the concrete both as to strength and chemical action. The amount of inert fillers used must be determined by careful tests.

The waterproofing effect of inert fillers depends upon the void-filling quality of the material used and upon the grade of workmanship insisted upon; the addition of a waterproofing compound to the concrete material coupled with poor workmanship will not assure watertight concrete.

It is an open question whether it is good engineering, especially on important structures, to omit precautions and methods of workmanship, which improve the quality of the resulting concrete in any respect, in order to reduce the cost and produce a somewhat inferior concrete which meets the present needs. There is a possibility that in gauging the amount of money to be spent in making concrete by the strength required, other factors may be lost sight of which may in time prove harmful to a structure which was supposed to be of the most durable construction.

There are numerous examples on record where structures have been built of concrete, in the too often used haphazard method of selecting proportions and aggregates and by inferior workmanship, due to lack of proper supervision, or lack of judgment, and feeling of responsibility, with the idea that concrete is concrete, which will withstand any usage as good masonry construction. This is a wrong conception of the importance of this class of work. The selection of proper proportions and well-graded aggregates of good quality, coupled with good workmanship, the proper consistency of the mix and the thoroughness of the mixing, depositing, compacting and spading are factors which must be considered and insisted upon if a good, dense, strong and durable concrete is to be obtained.

With such precautions employed, inert fillers or compounds used in the proper proportions, impermeable and good concrete should be obtained.

In presenting results of tests of waterproofing materials added to the ingredients of concrete, the proportions of the mixture are at times stated in two different ways. One method is to state that a certain proportion of waterproofing material was mixed with the cement and then the proportions of the test specimens are given as so much of the cement mixture to aggregate. Other tests are described in which an amount of waterproofing material equivalent to a certain percentage of the cement used is added to the concrete materials. The results of such tests cannot be correctly compared without reducing them to a common ratio between cement and aggregate.

When dry compounds are used from 1 to 2½ per cent. of the cement used is recommended by the manufacturers, while for the liquid compounds from 4 to 8 per cent. of the amount of water used is recommended by them.

The cost of concrete is increased by the addition of such materials from 80 cts. to $1.20 per cubic yard for dry compounds and from 50 cts. to $1 for the liquid compounds, per cubic yard of concrete.

Active Fillers.—Compounds which are added to the concrete mixture and which react with certain of the constituents of the cement to form other compounds which will be inert and fill the voids are included in this class. In general these materials are soaps and saponifiable oils. Inasmuch as the waterproofing effect of these materials depends upon a reaction which may or may not take place, objection has been made to their use.

(To be continued.)

On April 9th, M. Beatty and Sons, Limited, launched at Welland, the dipper dredge they are building for the C. S. Boone Dredging and Construction Company of Toronto. This dredge is of steel, 100 ft. long, 40 ft. wide, 10 ft. deep at bow, and 8 ft. at stern. It is of the crane type, the crane being 40 ft. long. The dipper is of 5 cu. yd. capacity, the dipper handle being 61 ft. long, which will allow it to make 40 ft. of water. The main engine is double cylinder 15 in. bore and 15 in. stroke. The boiler 10 ft. diam., by 12 ft. long, of the Scotch marine type. Each bow anchor or spud is operated by an independent reversible engine of 10 in. bore by 10 in. stroke, compound geared, the anchors being raised and pinned up by steel cable. The engine for handling the stern anchor is 9 x 9 in. compound geared. Located on [illegible] side of the deck forward, is a [illegible] in. double cylinder, triple drum engine, which is used for warping the dump scows into position. It is expected that the dredge will be completed and ready for towing by May 1st.

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OPPORTUNITIES FOR ENGINEERS.

Some very commendable food for thought is to be found in the presidential address of Frederic H. Fay, of the Boston Society of Civil Engineers. At the recent annual meeting Mr. Fay, whose associations with engineers over a number of years as division engineer at Boston for the United States Public Works Department, emphasized, as a quality of highest importance to the success of the young engineer, the ability to properly meet and mingle with his fellow-engineers. He should be, in popular vernacular, a "mixer," and to failure in this direction is accorded the lack of, or limited, success of many an engineer who has the other requisites, and who but for this discrepancy would undoubtedly achieve a far higher position.

To meet the demands which are born of dependence and reliance upon them in every field of activity, engineers must grow and become broader men.

The successful engineer of to-day and of to-morrow cannot be like the engineer of yesterday, who too often would retire into the technical recesses of his professional work and content himself with being the servant of other men. The engineer of to-day should be a broad-gauge man, aggressive, alert, in touch with public questions outside his own narrow field, and a leader—not a follower—of men. It is upon the development of these qualities in engineers themselves that the whole future success of the profession depends.

"The engineer should be a manager, and should give orders to others who can do the work under his direction as well as he himself could do it with the situation reversed. It should not be considered unprofessional for an engineer to be a capitalist, and, when he takes his proper place as promoter and organizer and shares in the profits of engineering enterprises, he will no longer be taunted with the saying that 'an engineer is only good to spend other people's money.' It is by acquiring individual strength that the engineer can give strength to the profession. It is well known that engineers of admitted proficiency often have to work under the direction of men who are unfitted by education and experience to direct engineering work. This is because the engineer is a workman while the other party belongs to the class of 'managers.' The engineer has not reached his proper rank until he can hold the position of manager, as well as that of a designer and supervisor of work.

"Engineers themselves are frequently responsible for the low estimate which the public places upon the value of engineering services. Chief engineers of corporations and public boards too often make the mistake of hiring engineering assistants at the lowest possible wage, under the false impression that by such rigid economy they are enhancing their own value in the minds of their employers. Many of us can name instances where young engineers of much ability and good training, but of somewhat limited experience, have been placed in charge of important pieces of work at salaries less than the lowest wage paid to skilled workmen employed by the contractors working under their direction.

"Such practices do grave injury to the whole profession and cheapen it in the estimation of the public. Furthermore, they tend to react to the disadvantage even of the chief engineer, for his employers will reason that if the rank and file of engineers can be hired so cheaply, engineers as a whole are a cheap lot, and high salaries are not necessary in any grade, even that of the chief engineer himself. The chief engineer who pays a fair wage, taking account of the time and money which the young engineer has spent in securing his education and

training (his working capital), will not only secure better, more loyal and more efficient service, but will help to raise the standard of the whole profession."

SASKATCHEWAN HIGHWAY IMPROVEMENT IN 1914.

The Provincial Highways Commission of Saskatchewan has a larger programme before it this year than ever before. This is perhaps owing to the fact that it is undertaking work which until this season has been carried on by the municipalities themselves. The road appropriation for the current year amounts to $1,500,000, one-third of which is to be devoted to bridge construction. Of this the Saskatoon high level bridge will come in for a considerable share, while approximately $100,000 will be spent on small bridges of steel and concrete similar to those described and illustrated in *The Canadian Engineer* for January 8th, 1914.

The Commission announces that by June 1st, approximately one hundred road gangs will be at work in the province.

INTERNATIONAL CONFERENCE ON CITY PLANNING.

During the last five years national conferences on city planning have been held annually in various cities of the United States, and have aroused such widespread interest that many American communities are now anxious to have the conference held in their city and are willing to contribute the funds for that purpose. The City of Toronto, therefore, is to be congratulated on being the first place on this side of the international boundary to entertain the conference, which this year will become international in scope and character. The financial difficulties have been overcome by a generous grant from the Dominion government, which has appointed the Commission of Conservation to act as hosts. The Ontario government and the City of Toronto are also contributing. The question of city planning is thus recognized to be of national, provincial and municipal concern. The Governor-General will open the conference and give an address.

The substantial assistance given by the Dominion government is evidence that the town-dweller, equally with the agriculturist, is receiving attention, and that not only the federal capital, but all our Canadian cities are receiving from the federal authorities such advice and assistance as the Congress will afford them. Invitations have been sent to all the cities and towns in the Dominion, requesting them to send delegations to the conference. It is felt that money could be spent to no greater advantage than in giving some of our city councillors the opportunity to come into touch with experts in civic problems from all over the continent. The aldermen will carry home ideas that, put into practice, will save their townspeople millions of dollars, besides acquiring a new sense of the responsibilities of their office and higher ideals of civic administration.

The scope of the conference may be gauged by a glance at some of the topics which will form the main themes of discussion. Among these may be cited: "The Relative Importance of City Planning as Compared with All Other Functions of City Government," by Andrew Wright Crawford, editor of the city-planning section of the Public Ledger; "Provision for Future Rapid Transit," by J. V. Davies, consulting engineer for the Brooklyn Rapid Transit Company; "Rapid Transit and the Auto Bus," by John A. McCollum, assistant engineer, Board of Estimate and Apportionment, New York City; "Protecting Residential Districts," by Lawrence Veiller, secretary and director of the National Housing Association, New York City; "Toronto's Water Front Development," by R. S. Gourlay, of the Toronto Harbor Board; "A Consideration of the Principles and Procedure of a Canadian Town-Planning Act," a draft of which is now being prepared by a special committee appointed by the Commission of Conservation; and "Recreation Facilities in the City Plan," by Henry V. Hubbard, professor of landscape architecture in Harvard University.

DIFFERENCE IN DENSITY IN PANAMA CANAL WATERS.

It is announced in the Canal Record of April 8th that forces of the meteorology and hydrology subdivision are making a study, at the lower end of Miraflores Locks, of a current caused by the difference in density of the water on two sides of the lower gates when the gates are opened for the passage of vessels to the sea. At the stage of a downward lockage when the surface of water in the lower chamber has been lowered to evenness with that in the approach, the water within the chamber is more than half fresh. It has, in consequence, less density than the sea water beyond the lower gates and when the gates are opened the heavier water thrusts its way inward against the lighter, causing a current opposed to the outward passage of a vessel.

Surface indications are that the current has a velocity of from three to four miles per hour. Being temporary, it causes no serious inconvenience and it is being studied principally to determine accurately the conditions for the manipulation of the towing locomotives. The density of sea water is about 2.5 per cent. greater than that of fresh water; a simple illustration of the difference is seen in the fact that chewing gum will float in sea water, but not in fresh. At the lower end of the locks, the difference in density of the water on both sides of the gates is less, because a considerable proportion of sea water is mixed with the fresh water in the lower chamber before the lower gates are opened. The conditions exist only at Miraflores and Gatun Locks, the water at both ends of Pedro Miguel Lock being fresh at present.

EDITORIAL COMMENT.

In commenting upon the question of contract vs. day labor in municipal work, as referred to editorially in *The Canadian Engineer* for January 22nd, the following observations appeared recently in "The Sanitary Record and Municipal Engineering" (England):—

As to how far English municipal engineers agree with the cogent reasoning which we have quoted we must leave it to them to speak for themselves. The practice which obtains in Canadian cities of the city engineer's department tendering in competition with contractors—a practice which does not obtain in this country—constitutes, it is asserted, a stimulant to the department and prevents a deterioration of organization, limits increase in the cost of work, and establishes a formidable reason for the employment of efficient and well-paid men, and is one which might perhaps advantageously be adopted in this country.

AMERICAN WATER WORKS ASSOCIATION.

The 34th annual convention of the American Water Works Association to be held in Philadelphia during the week of May 11th, will bring together some very prominent engineers, waterworks superintendents and manufacturers of machinery and supplies. The association has a considerable membership in Canada and the convention is commanding the attention of waterworks men throughout the entire Canadian field. No doubt the forthcoming convention will be attended in large number by Canadians interested in the papers, discussions, privileges and opportunities which it will present.

Preparations for the convention are practically completed. The headquarters will be at the Bellevue-Stratford, Philadelphia. The programme of papers is unusually interesting; advance copies have been issued, and discussions are being submitted by letter or prepared for presentation at the convention. One day has been set aside as Superintendents' Day—a decidedly good feature. A few short practical papers by waterworks superintendents will be presented.

The following are among the papers to be read and discussed at the other sessions:

"Investigations Into the Advisability of Substituting Agar for Gelatine as a Medium for the Determination of Bacterial Counts in Water Analysis," by W. U. C. Baton, Analyst in charge of Pittsburgh Laboratory.

"Sewage Pollution of Boundary Waters," by Allan J. McLaughlin, M.D., Surgeon, U.S. Public Health Service, Chief Sanitary Expert and Director of Field Work for the International Joint Commission.

"Present Day Water Filtration Practice," by George A. Johnson, Consulting Engineer, New York.

"Remarks on the Theory of the Pitot Tube," by N. W. Akimoff.

"Testing of Check Valves," by J. Walter Ackerman, Superintendent, Water Board, Auburn, N.Y.

"Equitable Hydrant Rentals and Better Methods for Apportioning Fire Protection Cost," by John W. Alvord, Consulting Engineer, Chicago, Ill.

"Use and Benefits of Pressure Recording Gauges," by J. M. Diven, Superintendent, Troy Waterworks, and Secretary of the Association.

"The Water Supply at Wilmington, Delaware," by Edgar M. Hoopes, Jr., C.E., Chief Engineer of the Water Department, and James M. Caird, Consulting Chemist and Bacteriologist for the Water Department.

"The Croton Water Supply: Its Quality and Purification," by George W. Fuller, Consulting Engineer, New York.

COST OF ROAD CONSTRUCTION IN UNITED STATES.

In 1904 the total expenditure on all public roads in the United States was $70,771,417. In 1912 the expenditure amounted to $164,232,365, more than twice as great. The expenditure per mile on public roads in 1904 was approximately $37.07; in 1912 it was $74.65. The expenditure per inhabitant in 1904 was $1.05; in 1912, $1.78.

The greatest progress in road-building has been made in the states which contribute from their treasuries toward the construction of state aid or trunk line roads. In 1904 there were thirteen states that contributed out of a general fund $2,607,000; in 1912 there were thirty-five states which contributed $43,757,438.

RANSOME FILTER RECOMMENDED FOR ADDITION TO TORONTO FILTRATION PLANT.

John ver Mehr Engineering Company, Limited, as Engineers, and William Cowlin & Son (Canada), Limited, as Contractors—Cost $1,066,282.

COMMISSIONER of Works R. C. Harris, of Toronto, has recommended to the Board of Control that a contract be awarded to the John ver Mehr Engineering Company, Limited, as engineers, and William Cowlin & Son (Canada) Limited, as contractors, for a $1,066,282 addition to the Toronto Island filtration plant. The Board of Control has approved of the recommendation and it will be discussed at the next Council meeting.

The existing plant is of slow sand design, while the new plant recommended is the Ransome drifting sand system. The plant will filter sixty million Imperial gallons per twenty-four hours, and may be overloaded to the extent of twenty per cent. for any period of ten hours.

The plant, as proposed, consists of ten filter units, and occupies approximately 2.4 acres. The nearest point is situated approximately 170 feet to the west of the westerly wall of the existing slow sand filters. The buildings consist of coal storage, chemical storage, chemical building, suction well and building, boiler house and pumping station, filter house and wash water tank. The coal storage, chemical storage and chemical house are under one roof. The suction well, boiler house and pumping station, filter house and wash water tank are separate structures. The coal storage building is connected to the boiler house by a passageway, while like connection is made between the pumping station and filter house. The coal storage, chemical storage and chemical building is to be constructed of concrete, while the others are to have concrete foundations with pressed brick walls and tile roofs.

Connection is made from the two existing 72-inch intakes by two 5/8 inch steel pipes of like dimensions, surrounded by 12 inches of concrete, conveying the water to the suction well, which is equipped with a system of double screens, and a gate valve, hydraulically operated, at the end of each intake. From this well, suction pipes run to three 36-inch centrifugal pumps, electrically driven. These suctions are placed so that water may be drawn from elevation 30, or 10 feet below zero lake level.

The sulphate of alumina coagulant is introduced to the raw water in pre-determined quantity, prior to its entering the suction well, and may be varied according to the quantity of water passing.

From the three centrifugal pumps, the water passes to the filters through a 72-inch steel pipe, diminishing at the extreme north end of the filter house to 36-inch. This conduit is supplied with a 72-inch Venturi meter, which automatically indicates, integrates and records the water passed.

The system comprises practically a combination of the slow sand and mechanical methods. The water is carried from the supply pipe previously mentioned, to the top of ten steel cylinders, each having an outside diameter of 50 feet. In the centre of each of these cylinders there is an open space of circular form, 16 ft. 8 in. in diameter, which accommodates the supply piping, the sand washer, and sand conveyer.

The operation is described by the ver Mehr Company as follows:

"The distinctive feature of the Ransome Drifting Sand Filter is the employment of a gradually moving body of sand as the primary or roughing filtration medium, which eliminates as a continuous process the main impurities from the water prior to its passage through the final filtration medium or stationary sand. Governed by its natural angle of settlement, the moving sand almost imperceptibly gravitates, grain by grain, towards a system of collecting or extracting points at the bottom of the filter, arranged in a system so as to divide the filter into thirty equal sections. The sand with added water then passes to a central collecting point and is elevated to a sand washer placed centrally at the top of the filter, where, after being thoroughly and automatically cleansed of its impurities, it will be continuously caught up by the incoming water and deposited again on the moving sand surface at the top of the filter. The stationary sand forms naturally into pyramidal shapes with rounded tops offering a large surface to the passage of the filtering water. This surface is more than twice the plan area of the filter. The stationary sand rests upon gravel, from which it is separated by perforated brass screens, and the water is collected from a number of brass and cast iron collecting pipes from the bottom of each of the thirty sections.

"The elimination of the main impurities by the moving sand will enable this filter to carry on a continuous filtration process without washing back for periods of about one week, thus assuring continuous and practically uniform results.

"The loss of head in the filter gradually increases from a minimum of 5 feet at the commencement of a run to a maximum of 12 feet, when it becomes necessary to wash back the filter with a high-rate wash of fifteen gallons per square foot per minute, using filtered water, for which an overhead tank, with duplicate pumps to fill it, will be provided. The slow rate at which the filters clog, removes the desirability of providing rate controllers, as all that is necessary is that the attendant should adjust the main outlet valve once or twice a day to the desired requirement.

"The operation of the sand extractors is such that they are controlled by the raw wash water, which, if shut off, causes the extractors to cease operating and when the water is supplied again, to start working as before.

"With this type of filter the need for coagulating and sedimentation basins is avoided; indeed, as proved by the slowness of the clogging of the stationary sand and the efficiency of filtration, the drifting sand is much more effective in removing the impurities than sedimentation basins. Thus it is not proposed to provide mixing, coagulating or sedimentation basins, but to apply the coagulant to the main raw water pipe opposite the chemical house. The mixing of this coagulant with the water will be perfect in that it will first of all have to pass through the suction well, where it will receive considerable natural mixing and afterwards through the pumps, where the mixing with the raw water will be complete. Further intimate mixture between the sulphate of alumina and the raw water takes place at the sand washer and the distribution pipes, so that by the time the water reaches the filter a thorough mixture is absolutely assured."

Approximately two per cent. of the raw water supply is used to wash the drifting sand, says Commissioner Harris. The stationary cone is back washed with filtered water, which is estimated by the ver Mehr Company at one per cent. of the effluent. The sand in each filter has a depth of 9 feet.

The filter units are made of steel, supported by columns, and all of the valves are controlled hydraulically from operating tables placed on a central elevated gallery, located between the two lines of filters and on a level with the top thereof.

Extending around the periphery of each filter is an overflow in view of the operator, who controls the supply accordingly. This overflow returns to the suction well.

The water from the filters discharges into steel mains through an indicating, integrating and recording Venturi meter, and travels thence by steel main to a point 50 feet north of the filter house, where it is discharged into the present clear water reservoir connected to the slow sand filtration plant, by a conduit to be laid by the city.

All of the apparatus in connection with these filters is enclosed by buildings erected on existing ground.

The tenderers agree to complete and put in operation one-half of the plant by August 1st, 1915, and the whole by November 1st, 1915. All of the structures are to be erected on existing ground, no new sand fill being required.

Commissioner of Works R. C. Harris, in his report to the Board of Control recommending the acceptance of the ver Mehr Company's tender, said that he believed the only considerable hazard which may eventuate during the construction period, would be caused by reason of the excavation for the additional plant being carried to a depth below that of the existing filters. When the ground water is removed from the excavation for the purpose of constructing the foundations, the flow of water from the present plant might cause a sand movement which would diminish the present stability of the filter beds. The contractors have made provision for carrying out the work in a manner which should eliminate this danger. They propose to drive sheet piling along the entire west side of the excavation—that is, the side nearest the westerly wall of the existing plant. By this means it is felt that serious sand movement will be obviated.

The specifications under which tenders were called were most severe as regards bacterial efficiency. The ver Mehr Company guarantees that their plant will remove 90 per cent. of all organisms where there are 50 to 500 bacteria per c.c. in the unfiltered water; 95 per cent. of all organisms where there are 500 to 2,000 bacteria per c.c. in the unfiltered water; and 98 per cent. of all organisms where there are 2,000 or more bacteria per c.c. in the unfiltered water. There is also guaranteed the removal of 98 per cent. of the B. Coli. All turbidity must be removed, leaving a bright, colorless water free from taste. These results are guaranteed with the use of not more than one grain of alum per Imperial gallon of water under average conditions.

The ver Mehr and Cowlin companies were unable to secure insurance bond covering these guarantees of bacterial efficiency, but offered their personal bond, guaranteed by their parent English companies, for $250,000, indemnifying the city against any failure in this connection. They have arranged with English insurance companies for the necessary bond covering the balance of their guarantee and responsibilities.

It is understood that the ver Mehr and Cowlin companies were the only tenderers for the plant willing to accept the contract with clause 200 included. This clause, which some thought might be confiscatory under certain conditions, reads as follows:

"The plant shall be fully tested for clarity of effluent and bacteriological efficiency, by the Medical Officer of Health or his representative, within three months after

the plant, or portion thereof, has been placed in operation, and in the event of failure to fulfil the guarantees, the entire plant may, at the option of the Commissioner, be entirely rejected, and all moneys paid to the contractor shall be refunded to the Corporation, and may be recovered from the contractor or his sureties. In the event of dispute between the Medical Officer of Health and the contractor, the matter in dispute shall be referred to the Commissioner, whose decision shall be final and binding."

In the early part of 1913, Mr. John ver Mehr submitted a proposition to the City of Toronto covering the erection, without cost to the city, of a demonstration Ransome filter at West Toronto, to filter the Humber Bay water.

With the consent of Council, this plant was built and operated under the direction of the Medical Officer of Health and of Dr. G. G. Nasmith, Director of Laboratories, for thirty-three days during last summer. In reporting on this test, Dr. Nasmith said that daily analyses of the water before treatment on Standard Agar was 1,458 per c.c., while the effluent showed 15 bacteria per c.c., giving a total bacteria removal of 99 per cent. B. Coli. was removed to the extent of 98 per cent., while 99 per cent. of the red colonies growing on the neutral red bile salt agar (Dr. Houston's formula) were removed. The amount of alum used varied from .85 grain to 1.5 grains per Imperial gallon. "The effluent," said Dr. Nasmith, "was invariably bright and sparkling, without any trace of turbidity."

Commissioner Harris says that this test was made with water from Humber Bay which was of a uniformly bad quality. During a portion of the time the unit was under test, the city officials increased the turbidity of the water to a point beyond that found in the water at the intake mouth, south of the Island, when at its worst. The test unit at West Toronto was of one-half million Imperial gallons daily capacity.

FORESTRY CONVENTION IN NOVA SCOTIA.

For five or six years, those interested in the forests of Nova Scotia have been endeavoring to secure the annual Convention of the Canadian Forestry Association, which has hitherto been held east of Fredericton, N.B. This year the Government of Nova Scotia invited the Canadian Forestry Association to meet in Halifax, and discuss the forest problems peculiar to that province. This invitation was warmly seconded by the lumbering, farming, commercial and educational interests. At a meeting of the directors of the Forestry Association, in this city, with the president, Mr. William Power, M.P., of Quebec, in the chair, it was decided to hold the convention in Halifax, September 2, 3 and 4. Already a number of leading lumbermen and authorities on forestry from the maritime provinces, Quebec, Ontario and places further west have signified their intention of taking part. Mr. James Lawler, Ottawa, Secretary of the Canadian Forestry Association, who recently visited Nova Scotia, and who will return there in the summer to hold a series of meetings in preparation for the convention, reports great interest among the owners of timber lands in Nova Scotia in the effort to conserve this very important industry.

Reconstruction of the Brooklyn Bridge has been studied out by the Department of Bridges, New York City, in detail during the past ten years. The project has now been taken up by the Commissioner of Bridges, F. J. H. Kracke. The work in question is likely to mean the entire replacement of all the suspended structure; that is, everything except towers, tower cables, and anchorages. The existing stiffening trusses and floor are not adequate for permanent service under present overloading, and give no additional capacity for the further loading which the bridge might be made to carry.

PAINTING CONCRETE SURFACES.

THE painting of concrete and cement surfaces is one of the many new problems that modern conditions have brought to the master painters of the present day. Ordinary linseed oil paints cannot be applied with success directly to cement or concrete surfaces on account of the lime present in the cement. The action of this alkali is to destroy the oil, causing rapid fading of colored paints, and chalking and scaling off of the material. Therefore, it is necessary, if a linseed oil paint is to be used, that the surface be first thoroughly saturated with a neutralizing wash. The most approved method is to use a solution of zinc sulphate in the proportions of 3 lb. to a gallon of water. A cement surface treated with this wash and allowed to dry can be painted with any high-grade linseed oil paint without danger from alkaline action, and with the assurance that results will be lasting, as if applied to wood.

Water color paints should not be used for exterior cement coating, as they do not form a waterproof coating (one of the most important requirements of a cement paint) and offer no protection from deteriorating influences.

All new laid cement surfaces, either exterior or interior, should be allowed to become thoroughly dried out and hard before painting, and the best results have been obtained where the work has stood not less than a month before paint was applied. If the surface is dry and the paint right, it will penetrate freely on the first coat, filling the pores and rendering peeling impossible, but this would not be the case if applied over a damp surface.

Exterior cement paints should dry to a flat or semi-flat finish in order to carry out the stone or cement effect. Nothing looks more out of place than a full gloss paint applied to exterior cement surfaces.

Many of the ready prepared cement floor paints, the quick drying vehicle of which is largely China wood oil, have been found to give excellent results. Mr. R. H. Langston, in a paper read at the Illinois State Association of Master House Painters, Chicago, strongly recommended their use until such time as a more complete knowledge of the requirements in mixing of this material can be obtained.

There is no doubt that, for some time to come, the master painter will be feeling his way, step by step, in the new realm of modern surface painting which cement construction has forced upon him. It will tax the brain of the paint chemist to formulate the vehicle with which to destroy the alkaline base with which cement surfaces are loaded.

Time and the elements are the only factors which will buy time exposure, and to arrive at the point of absolute elimination or of perfect assimilation of the vehicle with the cement surfaces that are coated, will require patient effort. We are all aware that the goal has not been reached by any means, but constant scientific research will land us in the promised land of perfection, as it is doing in every other line of industrial development.

Surface Finish for Concrete Floors.—A new method of finishing the surface of concrete floors has been recently introduced. From 15 to 30 per cent. of iron filings are mixed with the cement dry, and one part of this mixture to two parts of sand makes the material for the top coat, which varies from ½-in. to 1-in. in thickness according to requirements. It is said to make a hard, durable and non-slippery floor surface.

RAILROAD TUNNEL CONSTRUCTION AND VENTILATION.

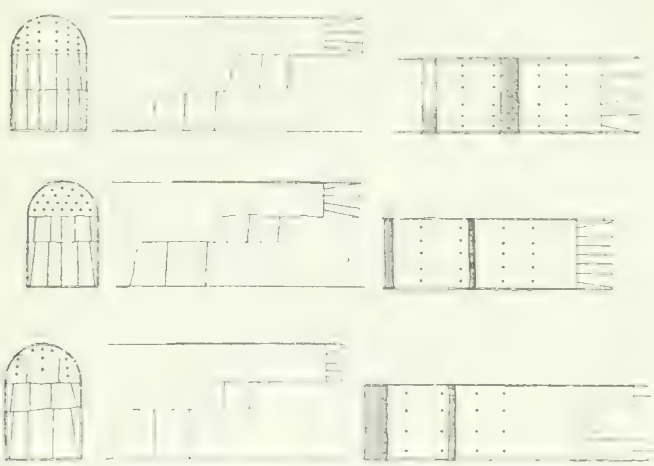
THE committee on track of the American Railway Engineering Association has presented the following conclusions after several years' study of tunnel construction and ventilation for railroads:

1. Railway tunnels, as ordinarily constructed in the United States, are more economically built by first driving the heading entirely through, but such method usually requires a greater length of time for completion of the tunnel.

2. For material requiring support the top heading should usually be driven.

3. It is economical and expedient to use an electric shovel or an air shovel for the removal of the bench where the section of the tunnel permits its safe operation; and where the material does not require support there are advantages in low cost and quick removal of the bench in driving the heading at the subgrade line.

4. Where the time limit is of value, the heading and bench should be excavated at the same time, the heading being kept about 50 ft. in advance of the bench. Where the material of roof is not self-supporting and timbering



Typical Methods of Railroad Tunnel Construction. Fig. 1 (top)—V-cut used in hard rock with few seams. Fig. 2 (centre)—Hammer-cut for moderately hard rock with seams. Fig. 3 (bottom)—Cut used in soft rock or hard clay.

is to be resorted to, the bench should not be removed until the wall plates are laid and the arch rib or centering safely put up.

5. Opposing grades should preferably not meet between the tunnel portals so as to put a summit in the tunnel. Where practicable, the alignment and ascending grades in the tunnel should be in the same direction as the prevailing winds.

6. The accompanying drawings are representative of American practice in single-track tunnel construction, where the time limit is of value.

Explanation of Figures.—The typical method in hard rock with few seams is shown in Fig. 1. The heading in material of this kind is usually driven by a V cut, using from sixteen to twenty-two holes about 8 ft. deep. The holes near the middle of the heading are drilled so as nearly to meet at the end. These holes are shot first, then the second row and lastly the outside holes. The arrangement of these holes will vary slightly, according to the way the material breaks.

The bench in material of this kind is usually taken out in two lifts of almost equal weight. The sub-bench is drilled from 20 to 40 ft. in advance of the bench. From four to eight holes in a row, with 6 or 8-ft. face, are used in both sub-bench and bench. One or two rows of holes may be used. The centre holes are shot first and the side holes last.

For moderately hard rock with seams the method outlined in Fig. 2 is employed. The heading is usually driven by a "hammer" cut, using from fourteen to twenty holes 6 to 10 ft. deep. The bottom row of holes is inclined at an angle of about 30 deg. The rows are shot in succession, beginning at the bottom. The holes should be arranged to suit the seams in the material.

The bench is sometimes taken out in one lift, but usually in two, with the sub-bench not as deep as the bench. The sub-bench is best drilled from 20 to 40 ft. in advance of the bench. From four to six holes in a row may be used with from 6 to 10-ft. face. The centre holes are shot first and the side holes later.

The method indicated in Fig. 3 is used only when the material is so soft that the heading cannot be driven for the full length of timber used for the wall plates. Drifts about 4 ft. wide and 6 ft. high are driven for each wall plate, and the core is taken out as the timber rings are put in. Three or four holes from 3 to 5 ft. deep may be used in each drift. The amount of shooting necessary depends entirely upon the softness of the material, which can often be picked. The core may be soft enough to pick, or may be shot with from four to eight holes, drilled either from the face as shown or from the sides of the drifts.

In this class of material the bench is shot in one or two lifts. Only a few holes are necessary.

Tunnel Ventilation.—Most practicable, effective and economical artificial ventilation for tunnels carrying steam-power traffic is to be obtained by blowing a current of air into one end of the tunnel for the purpose of removing, or of diluting and removing the smoke and combustion gases at the opposite end. As practised in America, this way of procuring ventilation partakes of two methods:

1. To blow a current of air in the direction the train is moving and with sufficient velocity to remove the smoke and combustion gases ahead of the engine.

2. To blow a current of air against the direction of the train with velocity and volume sufficient to dilute the smoke and combustion gases to such an extent as not to be uncomfortable to the operating crews and to clear the tunnel entirely within the minimum time limit for following trains.

RAILWAY CONSTRUCTION IN SIAM.

The Director-General of the Siamese Railway Department is the authority for a report of steady construction work on the Siam Northern line. The railhead is now at kilometre 476, so that only 190 kilometres (kilometre = 0.62 mile) now separate Chiengmai from railway communication with Bangkok, the capital. Lao (Northern Siamese) labor is employed where formerly Chinese labor was considered indispensable, and the results are most satisfactory. Operations are progressing in two divisions, one from railhead to Lampang, the other from Lampang to Chiengmai. The Meh Yome bridge is completed, and in the meantime track laying is going forward on the other side of the Meh Yome and has progressed 16 kilometres. The 1,400-foot tunnel at Pang Pakan, pierced several months ago, is being lined and will be completed by the time the railhead reaches there. Koon Tan, a 4,265-foot tunnel is being pierced, 1,200 feet having been completed.

THE DIESEL ENGINE.*

ALTHOUGH the progress made has been to some extent disappointing, the Diesel marine engine is finding increased employment in sea-going vessels. Great Britain has hitherto played a comparatively small part in this development, but several British firms are now undertaking the manufacture of such engines, and Burmeister & Wain, the Danish engineers who have had so much to do with the development of the system, have established works on the Clyde. The current year should witness a considerable addition to the number of oil engine ships. From 15 to 20 new large motorships were put into service. The engines fitted are of the two-stroke or the four-stroke cycle. Those in the former class include some of the largest vessels yet fitted with Diesel engines, such as the "Hagen," of 5,460 tons, the engines for which were supplied by Messrs. Krupp, and the "Wotan," of 5,703 tons, while the four-stroke cycle vessels include the "Siam," of 5,296 tons, the "Annam," of the same tonnage, and the "Fionia," all engined by Burmeister & Wain. The last vessel is the most powerful. She is equipped with two 2,000-i.h.p. Burmeister & Wain Diesel motors of the four-cycle type, and the power of each of these motors is as high as any yet constructed for marine work.

It is felt that the four-cycle engine has made far greater strides for ship propulsion than was first thought would be the case when the motorship made its appearance. Moreover, the results which have been obtained from motor-vessels in which this type of engine is installed have, on the whole, been rather more satisfactory than those with the two-cycle engines. With regard to the latter type, a good deal of difficulty has been experienced owing to cracked cylinder covers and also cylinder liners. Cast steel, which was employed in certain cases for cylinder heads, has been abandoned, and with the special cast iron now generally employed the cracking has been largely abolished.

Air-Compressor Troubles.—Experience in service has shown, however, that the main trouble which has arisen in the marine Diesel engine is with the air-compressors. Several serious breakdowns have been attributed to the presence of oil in the air-compressors, and the explosions which have taken place in one or two instances with compressors of good design can be explained only by the breaking down of the oil of very high flash point which has been employed. Investigation has shown that under a combination of high temperature and pressure the oil had become carbonized. The danger is a very real one, but the problem is one which ought not to be difficult of solution, and it has been suggested that a committee should investigate the whole subject and devise methods for the employment of more suitable lubricants to overcome a trouble which if not remedied will seriously retard the progress of the Diesel marine engine. That progress is already checked by the high price of oil fuel, and if technical difficulties are added to commercial disadvantages the outlook will be heavily clouded.

In this country Messrs. Swan, Hunter and Wigham Richardson have fitted Neptune Diesel engines to the cargo vessel "Arum." The machinery in this case consists of two sets of reversible single acting Diesel oil engines of the marine type working on the two-stroke cycle. The engines are rated at 1,150 h.p. This ship is the first of a fleet of the same type. At Dundee two vessels under construction are to be fitted with Diesel engines of 2,000 and 2,200 h.p. respectively. Messrs. Beardmores have supplied crude oil engines for some small ships, and Messrs. Yarrow have also done work in this field. It is understood that one of the ships being built at Harland & Wolff's Glasgow yard is to be fitted with Diesel engines. A large number of small ships have been fitted with marine oil engines of other types than the Diesel. The Kromhout is one which is now being largely employed, the ease of reversing associated with it having brought it into favor.

Oil Engines in Warships.—Apparently little progress has been made with the problem of the application of the oil engine for very large ships, and in particular for battleships, although experimental work is progressing favorably with two or three firms interested in this question. It is hoped in Germany that two 12,000-h.p. Diesel motors will be completed before the end of the current year, after which the problem of the motor-battleship may be advanced a step further. Submarines are now practically universally equipped with Diesel engines, and there is a distinct tendency to increase the size and power of these motors. Although during the past year none of the submarines for any country had greater power than 2,000 h.p. on twin screws, engines are being built in the chief European countries in units up to 2,000 h.p. for installation in a much larger type of submarine than has hitherto been common. It can, however, by no means be guaranteed that these engines will be a success, as the difficulties involved are excessive owing to the high speeds of revolution necessitated by the limitations of space and weight.

The Diesel Motor.—Engineering development is not always mainly dependent upon the engineer, who may be restrained by a number of commercial considerations which he is by no means able to control. This appears to apply particularly to the case of the internal combustion engine, the progress in which must inevitably be largely determined by the price at which the necessary fuel is available. For this reason, the high price of oil which has prevailed in Europe during last year had a distinctly detrimental effect upon the progress of motors using this fuel, and there can be no doubt that the oil-engine trade so far as this country is concerned, would have been much larger had the anticipated reduction in the price of heavy oil been made. Present indications do not point to any marked change in this direction, but greater attention is being paid to the utilization of tar oil, which is widely employed on the Continent, and possibly in a year or two's time there may be a modification in the existing circumstances.

Gas Engines.—Despite the adverse conditions, the use of the internal-combustion motor grows more widespread, and business during 1913 was exceptionally good —probably the best on record; and while the gas-engine trade would have been still larger to-day had it not been for the advent of the Diesel (the talented inventor of which died in tragic circumstances during the year) and the semi-Diesel engines (which compete with it in the larger and smaller sizes respectively) it is nevertheless in a healthier state than ever previously. This statement refers mainly to the producer-gas engine, although the use of coke-oven and blast-furnace gas for motive power has shown considerable increase. There is still much to be done in this direction, and manufacturers may regard it as one of their best spheres, for the economy in operation at mines and steel works is very great. This point is all the more to be emphasized by a consideration of a probable increase in the amount of coal which will be sub-

*Abstract from London Times Engineering Supplement, January 14, 1914.

jected to destructive distillation for the production of heavier and lighter oils. The number of very large gas-engine units built for this country has, however, not been great, but as with the present relative prices of gas and oil the gas-engine shows to good advantage in fuel costs, the demand for the small and medium powered producer-gas plant is extremely brisk.

Few novel features were introduced during the past twelve months in gas-engines, the chief point of interest being the increasing employment of fuels other than coal in places where they are readily obtainable. Sawdust is giving good results in numerous cases, while peat and charcoal are also employed with advantage when slight modifications are made in the producers. So much experience has been gained with the gas-engine during the last decade that one is inclined to consider its design as near the limit of perfection as that of the steam-engine, at any rate so far as the present-day type is concerned. But the gas turbine still remains an unsolved problem commercially, and there is absolutely no practical development to be recorded during 1913. The Holzwarth machine, from which at one time a good deal was expected, has up to the present received no real application, and although several inventors are now working on a type in which water is injected into the turbine, no definite progress is to be recorded.

Only in one phase does the development of the gas-engine seem to be at a standstill—its use for marine purposes and the hopes that were raised a few years ago are far from being fulfilled. It is now generally felt in most quarters that the future of the marine internal-combustion engine lies with the oil motor, and, although there are certain engineers who take the opposite view, their number is not great. A few gas-engine driven vessels were put into commission during the year, but apart from one motor coaster with two 150-h.p. motors, they were mainly barges with engines up to 100 h.p., and usually not much over 50 h.p. They were practically all built on the Continent, and chiefly in Holland.

Oil Engines.—Although the volume of the oil-engine business is probably no larger than that of gas-engines, the subject is one of greater interest owing to the development being more recent, with a consequent possibility of the introduction of more novelty in design and application. One fact of importance may first be noted, that the reputation of the few British firms building stationary Diesel engines has increased considerably, while the British semi-Diesel engine for land work is probably as good as, if not superior to, any built abroad. The sale of the former type in Great Britain has been very seriously affected by the high price of oil, but an increasing field in Canada, India, South America, and in other parts of the world has prevented any lull in the progress. There is a very marked tendency to favor the high-speed type in powers up to 500 h.p. for driving dynamos, pumping plants, and similar purposes, and it is quite fair to say that in spite of the difficulties which its design involved, the Diesel motor running at 250 to 350 r.p.m. is now as satisfactory a machine as the slow-speed type of 150 to 180 r.p.m. In the higher powers (750 h.p. and over) the two-cycle slow-speed engine is being favored, although the number constructed is at present relatively small. None of these (for land work) is yet being built in England, but many of the prominent firms on the Continent are doing quite well in this direction, the largest motor constructed being one of 4,000 h.p. with six cylinders, running at about 130 r.p.m., just completed by Messrs. Sulzer for Harland & Wolff. This will shortly be put into service, and its success will probably have a distinct influence on the development of the high-powered stationary oil-engine.

Semi-Diesel Engines.—The year was specially important and interesting to the manufacturer of the type known as the semi-Diesel engine—that is to say, the low-compression, heavy-oil engine. Orders were plentiful with practically all the firms of established repute, on both the stationary and the marine side, and several new types were put upon the market. There was no radical alteration in the design of any of them, nor do the new engines show any remarkable modification from the usual type. Larger powers were, however, constructed than were previously thought practicable, the biggest being one of 80 h.p. per cylinder, or 320 h.p. in four cylinders. A large number of such motors have now been built, and it seems possible that even higher powers may be obtained, although probably 500 h.p. will be the limit.

The prospects for 1914 appear to be very good, and although the amount of business done will probably not be so great as that during 1912 and 1913, the difference will not be very marked, for the internal-combustion engine has shown itself to be essential in practically every sphere of power employment, and moreover, the field of application is widening to a considerable extent every year.

CONCRETE LAID IN PANAMA CANAL.

The amounts of concrete laid in the major features of the Panama Canal and its auxiliary works to March 1st, 1914, are as follows:—

Gatun Locks	2,068,424	cu. yds.
Miraflores Locks	1,506,563	" "
Pedro Miguel Lock and Dam	929,232	" "
Gatun Dam and Spillway	232,256	" "
Miraflores Dam and Spillway	79,004	" "
Pedro Miguel-Miraflores duct line	6,193	" "
Central Division	1,271	" "
Balboa terminals	69,006	" "
Cristobal terminals	63,785	" "
Hydro-electric station	14,323	" "
Transmission line	6,030	" "
Aids to navigation	*5,000	" "
Relocated Panama railroad	63,123	" "
Permanent buildings, Balboa	7,202	" "
Total	5,053,311	" "

*Approximate.

Including the work on fortifications, the pontoon barge piers at Paraiso, Quartermaster's construction, municipal engineering, etc., the total concrete placed by the Canal forces is well above 5,000,000 cubic yards.

WATER POWER DEVELOPMENT IN SPAIN.

It is stated that the successful competitor for the privilege of undertaking the development of water power in the Department of Calabria authorized by an Act of the late Italian Parliament is La Società delle forze idrauliche della Sila, composed of La Banca Commerciale, Le Ferrovie Meridionali, la Società Meridionale di Elettricità, and La Société Franco-Suisse of Geneva. Inasmuch as there are few industries in the region to be developed, the work at present in contemplation is for the construction of a single electric plant, developing 50,000 horse-power; the capital necessary for this first undertaking is estimated at $8,000,000 to $10,000,000, and will be furnished by the four societies named. The dykes to be constructed in carrying out the undertaking outlined will also serve the double purpose of regulating the flow of water from the mountains, protecting the plain region from drought and from destructive inundations.

NEW EQUIPMENT IN HAMILTON, ONT., PUMPING STATION.

THE high level pumping station on Ferguson Avenue, Hamilton, is now equipped with electrically driven turbine pumps replacing the former steam plant. This station supplies water to two separate levels, making it necessary to install two different sets of pumps and each set was duplicated in order to make it sure that at least one set would always be available.

In Fig. 1 the two pumps in the foreground are Special No. 4, two-stage, Mather & Platt patent, high lift turbine pumps; each capable of delivering one million Imperial gallons per 24 hours against a total head from all causes of 131 feet. These pumps are direct-connected by flexible belt-laced couplings to 40 k.v.a. C.G.E. synchronous motors with direct connected exciters. On test at the factory, a pump efficiency of 79% was obtained, which is remarkably good for this size of pump.

The pumps for the higher level are shown in the background of Fig. 1. They are two Standard No. 5 Four-stage Mather & Platt patent high lift turbine pumps; each capable of delivering one million Imperial gallons per 24 hours against a total head from all causes of 326 feet. These pumps were connected by flexible belt-laced couplings to two 100 k.v.a. C.G.E. synchronous motors with two direct connected exciters. These pumps were guaranteed to have an efficiency of 70% and actually gave 72% on the official test.

The switchboard shown in Fig. 2 was manufactured by the Canadian General Electric Company and consists of five natural black slate panels of the central station type, equipped with horizontal edgewise instruments and K-3 oil switches, each of which is tripped automatically through an inverse time limit overload relay. One panel is provided for the control of each synchronous motor and the centre panel controls duplicate incoming lines. A voltmeter is mounted on a swinging bracket at the end of the board and is arranged to read bus voltage on all three phases.

The line panel contains one oil switch for each of the two lines and a single set of meters consisting of: 3 ammeters, 1 polyphase indicating wattmeter, 1 polyphase curve drawing wattmeter, 1 polyphase watthour meter.

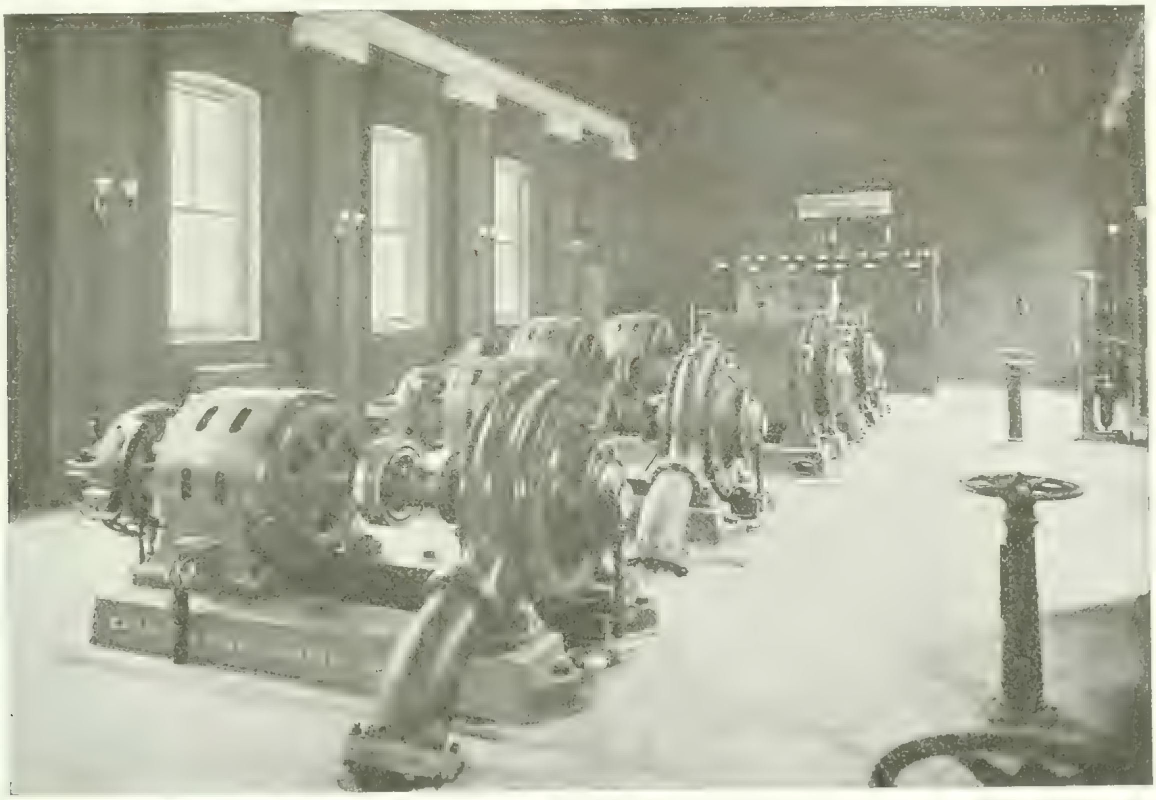


Fig. 1.—Ferguson Avenue Pumping Station, Hamilton, Ont.

Fig. 2.—Switchboard Arrangement.

Each synchronous motor panel is equipped as follows: 1 polyphase indicating wattmeter, 1 power factor indicator, 1 field ammeter, 1 rheostat mechanism, 1 D.P.D.T. field switch connected so as to excite the motor field either from a direct connected exciter or from a common exciter bus, 1 overload relay, 1 automatic oil switch, 1 starting compensator, 2 current transformers.

Starting arrangements for the motors are worked out in an unusual but very convenient way. Standard compensators are mounted on the wall back of the switchboard and are connected by bell cranks and operating rods to operating handles on the front of the panels, this mechanism being almost identical with the standard remote control oil switch mechanism. This arrangement, together with the busses, wiring, etc., is shown very clearly in Fig. 2, from which it will also be noted that, contrary to a very common practice, ample room has been allowed for the switchboard equipment.

UNPUTRESCIBLE WOOD.

ENGINEERS and others are annoyed by the rotting of railway sleepers, of piles, and of wood used to support galleries and in the building of ships, etc. Engineers, chemists, physicists, biologists, doctors, who for the construction of diverse apparatus, may need a wood possessing a maximum resistance to the causes of destruction, particularly humidity, are interested in this important question of the unputrescibility of wood. The ideal would be to find a wood able to resist putrefaction naturally. It appears from recent researches outlined in the Scientific American Supplement that the wood of the mangrove tree may be considered as absolutely unputrescible. Numerous samples of mangrove wood sent from French Guiana were, in 1909, placed at Collonges in a soaking pit in the depot of sleepers of the Paris-Lyons-Mediterranean Railway Company. These samples were surrounded with all the elements capable of producing the decomposition and rotting of the wood in the minimum of time. In spite of this the samples still remain in an excellent condition and show no signs of alteration. Why has the mangrove resisted decomposition and whence the particular and excellent qualities of this too little known wood? The grain of the mangrove is very close; hence it opposes a barrier to the invasion of water. The density of mangrove is about 110, that of oak is 70, and that of fir is 40. Moreover, mangrove wood has an amount of tannin quite sufficient to prevent the attack of insects and the multiplication of germs, damp, mould, and all the various micro-organisms which constitute the flora of the woods of different climates. The wood of the mangrove is marvellously resistant to flexion; its resistance is double that of oak, quadruple that of fir; nevertheless it is not at all brittle. To crushing, either at the end or across the fibres, it offers a resistance double that of oak and three times that of fir. It resists all attempts at twisting far better than either oak or fir, and is superior to them in suppleness. It is easily worked, and is as easily sawn as oak. It may, therefore, be concluded that mangrove wood merits employment on a large scale for numerous and varied purposes. It might be used for posts of electric lines on account of its unputrescibility, its resistance, and its suppleness. It is valuable for sleepers of narrow railways for its resistance to putrefaction and to crushing. It could be advantageously used for the special woodwork of mines.

ROAD ADMINISTRATION IN MANITOBA.

CONCERNING road administration in the province of Manitoba, Mr. A. McGillivray, Provincial Highway Commissioner, has the following to say in "The Manitoba Engineer," an annual publication of the Engineering Society of the University of Manitoba.

The construction of a system of highways suitable for the requirements of a province such as Manitoba is an expensive undertaking, nevertheless, there is no other expenditure of public moneys which will return more valuable and beneficial results than that used for the purpose of building good roads. In a province such as this, where agriculture is the predominant pursuit in the rural districts, good roads are essential to the development of all interests concerned. Not only is this true from a financial point of view, but also from a social viewpoint, as the isolation of the farm life is eliminated to a large extent by the introduction into a community of a system of well-built roads.

The administration of the road work in Manitoba, both with regard to construction and maintenance, is, primarily, entirely within the jurisdiction of the councils of the different municipalities of the province, each council having complete charge of all expenditures for this purpose within the limits of its own municipality. The assumption of this important duty by the municipalities should, and no doubt does, create a more general interest being taken in the whole question by the people, than if all the work of the province were centralized under one organization. The road to the market, although public property, may be rightfully considered an adjunct of the farm, and the thrift and prosperity of the residents of the district are largely reflected in the standard of roads obtaining through such community.

Funds for road improvements may be procured by a direct tax on the assessed valuation of rateable property in a municipality, imposed annually by the council thereof. Many municipalities in addition to the money tax, make use of the "Statute Labor Law," which gives a council the authority of imposing upon every person upon the assessment roll, the liability of one day's labor if assessed for a sum not exceeding $200; two days if assessed for a sum exceeding $200 and not exceeding $500; and one day for every additional $500 or fraction thereof. It is also the prerogative of any council to pass a by-law either permitting the labor to be actually performed on the roads within the "road beat" in which the party assessed is located, or to levy a money tax not exceeding $2 for every day of statute labor assessed.

The government of the province exercises no authority over the expenditure of municipal funds except where these funds are supplemented by a government grant. In such cases the work is performed according to plans and specifications of the Department of Public Works, supervised by an engineer of the department.

It is generally conceded that an up-to-date system of roads cannot be established in a growing province by municipal effort alone. The "Good Roads Act" now on the statutes of the province, provides for systematic aid to rural municipalities in building a system of municipal main or market roads and also in establishing a system of through highways from east to west and north to south across the province.

It rests entirely with the municipality to take the initiative in securing this government assistance. A map of the municipality showing thereon the roads or system of roads which the council desire to bring under the

operations of the "Act" is forwarded to the highways department by the municipal council.

The highways department consists of a board of three commissioners, appointed by the Lieutenant-Governor-in-Council, whose duty is to assist the municipal council in formulating schemes of highway construction under the provisions of the "Good Roads Act"; to compile statistics and collect information relative to the mileage, character and condition of the roads in the several municipalities of the province; to investigate the various methods of construction best adapted to the various sections of the province and establish standards for the construction and maintenance of highways in various sections, taking into consideration the natural conditions, character and availability of road building materials and the ability of municipalities to build and maintain roads constructed under the provisions of the "Good Roads Act."

On receipt of a plan of road improvements from a municipal council, an engineer of the department is sent into the municipality to make investigation and surveys preparatory to formulating the scheme proposed by the council and to estimate on the probable cost of carrying such scheme to completion. On the approval of any such scheme by the board and their decision being ratified by the Lieutenant-Governor-in-Council, the municipal council may pass the necessary by-laws putting the scheme into effect. Provisions are made in the "Act" for the issuing of debentures to cover the municipality's share of the cost of the work, the government agreeing to guarantee the debentures of the municipality.

The work is usually done by contract. The municipality advertises for tenders and lets the work on the advice of the highway board to the most acceptable bidder. All engineering services are supplied by the provincial government free of charge, and the work is carried through according to plans and specifications and under the directions of the department engineers.

Payments to contractors or otherwise in connection with the work is made by the municipality, the government remitting their share of expenditures made by the municipality on receipt of certified statements and declaration of the treasurer of the municipality that the amounts in question have been paid by him for work on the highways included in the scheme of improvements.

According to the provisions of the "Act," the provincial government may assist a municipality as follows:

(1) Two-thirds of the cost of the work for construction or improvement on a road which, in the opinion of the board, shall form a portion of the main highway across the province. The work done on these highways must be of a superior standard to an earth road, such as gravel, macadam or other pavement. All bridges and culverts must be of a permanent character, as concrete or steel on concrete foundations.

(2) One-half the cost of all work done on a system of roads within a municipality of a superior type to the earth road (such as gravel, macadam or other improved type of pavement) considered by the board and approved by the Lieutenant-Governor-in-Council as forming a system of main or market roads within such municipality.

(3) One-third the cost of all work done on a system of roads as mentioned in the foregoing paragraph, but where the type of road constructed is the ordinary earth grade and the bridges of such construction as timber or other material which cannot be considered of a permanent character. A municipality, however, may construct permanent culverts and bridges under this section and receive the full assistance of one-half the cost if they so desire.

The maintenance of all roads constructed under the provisions of the "Good Roads Act" is incumbent on the municipality and the provincial government has power to do any work of this character and levy on the municipality for the cost of same, where such a municipality neglects to perform the work required in keeping the roads in a state of good repair.

VANCOUVER TERMINAL IMPROVEMENTS OF THE CANADIAN PACIFIC RAILWAY.

Canadian Pacific Railway Company terminal improvements at Vancouver, B.C., are rapidly nearing completion. The general scheme embraces a passenger station and office building located on land immediately east of the present passenger station. Another dock 200 x 490 ft. has been built. A particular point of interest in this work was the use of piles 135 ft. long on the pier end. The main entrance to the station is located on Cordova Street with the main waiting room on the street level. Tracks are located about 25 ft. below this level and there is provision for four passenger tracks separated by wide platforms. Stairways and lift connect the two levels of the station and a separate foot-bridge is carried over the passenger tracks and directly connected with the waiting room at one end and with the stairways leading to the track level, thus giving access to the platforms without crossing the tracks at grade.

In order to avoid a grade crossing and the consequent delays to traffic between the city and the piers a steel viaduct is being built on the line of Granville and Burrard streets, passing over the tracks to the piers. An incline is also being built on the west side of the Granville Street viaduct to the wharf, thus giving access to the lower deck of the pier and freight sheds and to the water front.

The passenger station is a combination stone and brick structure with a steel frame. The station is divided into two principal levels on the lower of which are the baggage, mail and express rooms while on the upper are the ticket offices and waiting rooms. Above the public rooms in the station the space will be devoted to the general offices of the railroad company. The interior arrangement of the office space will be on the unit system and each unit will have complete heating and lighting facilities with partitions that may be readily installed or removed as changes in the arrangement of office accommodations become necessary.

The principal problem was to provide easy and economical communication between the city, the railroad station and the piers, these last introducing an element which is unusual in most railroad terminals so far as passenger traffic is concerned.

It is expected that the station will be ready for occupancy during the summer and that the steamship station facilities will be available somewhat earlier, although, due to the necessity of removing the old station before the viaduct can be built on the extension of Granville Street, the use of the present grade crossing over the freight yard tracks will have to be maintained for a month or two longer.

Messrs. Barrott, Blackader & Webster, of Montreal, are the architects for this work. Westinghouse, Church, Kerr & Co., of Montreal, are the engineers for the complete design, construction and equipment of the terminal, working in co-operation with the officials of the Canadian Pacific Railway.

Coast to Coast

Winnipeg, Man.—The Talbot avenue sewer at Winnipeg has been completed at a cost of $19,259.17.

Brantford, Ont.—It is stated that the T.H. and B. Railway will increase its yard accommodation in Brantford in the near future.

Sydney, N.S.—The Sydney board of trade is opposing the passing by the legislature of Nova Scotia of the Nova Scotia Tramway and Power bill.

Port Arthur, Ont.—Of the supplementary expenditure granted for roads in Ontario, $16,700 has been allotted for roads in the Port Arthur district.

Vancouver, B.C.—Overtures for a joint water supply have been made to the civic waterworks committee of Vancouver by a deputation from the South Vancouver municipal council.

Medicine Hat, Alta.—A scheme for street lighting at Medicine Hat at a cost from $35,000 to $50,000 is being advocated by the civic lighting committee and supported by the mayor.

Toronto, Ont.—The supplementary grants of the provincial government include $433,950 for expenditure on colonization roads, and $75,000 for the disposal of the Highways Commission.

Winnipeg, Man.—Several months ago, a new industry for the purification of sewage, was installed at Winnipeg at a cost of $40,000. It is now in full operation, and is stated to have given splendid results.

Montreal, Que.—The electrification of its terminals and the addition of two tracks to the present tracks feeding Windsor Street station at a cost of $1,000,000 are among the plans the C.P.R. is considering.

Fredericton, N.B.—It is understood that an arrangement has been completed whereby the Federal Government agrees to build the big bridges over the St. John and Kennebecasis Rivers on the St. John Valley railway.

Toronto, Ont.—York township council was defeated in its effort to gain powers from the legislature to force the city of Toronto to supply the township with city water by the decision of the private bills committee of the legislature.

Ottawa, Ont.—A deputation from Peterboro district will shortly interview the Government at Ottawa to present to the Government a petition asking that attention be given to the conservation of water power in the Trent district.

Transcona, Man.—It has been announced from headquarters that on May 1st the new C.P.R. yards in North Transcona, the second largest individual railway yards in the world, with 105 miles of trackage available, will be formally opened.

Toronto, Ont.—In a recent address on "City Planning" at the City Development Exhibition, Mr. J. P. Hynes advocated the advisability of inaugurating a steam railway service to give adequate transportation facilities to residents in the suburban districts of the city.

Winnipeg, Man.—It is stated that the public works department of the Dominion Government will commence work upon the docks and river front improvements at Winnipeg as soon as the river is free of ice. Preliminary expenditures are estimated at $25,000.

Halifax, N.S.—Plans and a report are being prepared by the city engineer to show in detail the watershed owned by the city and the area that should be acquired in order to secure a water supply beyond contamination. These are to be submitted to the board of control and then to the city council for approval.

Toronto, Ont.—It was reported at Toronto that Mr. David McColl, first vice-president of the C.P.R. has stated that eventually all the north shore line to Winnipeg is to be double-tracked, and that part will be double-tracked shortly; also that finally the Transcontinental from North Bay to Winnipeg will all be double-tracked.

New Liskeard, Ont.—Engineer Fullerton has handed in a report to the town council, with reference to the proposed new reservoir. He recommends the building of a circular wall of concrete, 16 feet deep, 50½ feet in diameter, which will be capable of holding 200,000 gallons of water. He further advises that a concrete wall, 6 feet in height be built above the wall of the reservoir, instead of a roof. No plans have as yet been prepared.

Ottawa, Ont.—The new Government-owned international storage elevator to be built at Calgary, for which tenders are now being called, is modelled after the two elevators now being erected by the Government at Moose Jaw and Saskatoon. It will have a capacity of 2,500,000 bushels, but will be built so that its capacity can be easily increased, if necessary. It will be thoroughly modern in every way and will be fitted with every variety of cleaning apparatus for grain.

Winnipeg, Man.—The statement of the civic light and power department at Winnipeg for the month of March, shows that the net cash receipts of the month, for current year only, reached a total of $83,046.59, an increase over the same period last year of nearly $25,000, or about 40 per cent.; the figures for March of last year being $58,358.04. The realizable earnings of the department for last month were $76,969, as compared with $55,637 for March of last year, an increase of $21,332, or about 40 per cent.

Montreal, Que.—It is reported from Montreal that construction work will likely be begun this year on the C.N.R.'s western line from Oliver to St. Paul de Metis, which is guaranteed by the Saskatchewan Government for 100 miles at $13,000 per mile. The work of cutting the right of way has been continued throughout the winter, and is now practically completed. About 15 miles of grading have been done. The line will run northward close to Battenberg, Egremont, Radway Centre, Clodford and south of Smoky Lane.

Oil Springs, Ont.—Nine drills have already been employed at Oil Springs since the flow of gas was struck on the Fairbanks farm, while arrangements have been made by the Union Gas Company for piping gas to Petrolea, and a number of carloads of 6-inch pipe have been unloaded. The gusher has had to be capped and will remain so until a system of regulators has been installed, which will reduce the flow and pressure to a degree that will be compatible with the staying qualities of ordinary gas pipes and the boiler furnaces.

Steelton, Ont.—It has been reported recently from Sault Ste. Marie, Ont., that artesian wells have been discovered in the western portion of Steelton. It is stated that two-and-a-half inch pipes have been driven down to a depth of 78 feet, and are now supplying a gush of water estimated to measure 350 gallons a minute; while the town's present consumption is 160 gallons per minute. It is expected there will be no need of chlorination of the water; and it is considered likely that the town will erect a pumping station and standpipe to control the supply.

Montreal, Que.—The installation of an elaborate interlocking switch system has been completed by the C.P.R. at the Windsor station in Montreal. All signals, levers, and

machinery are interlocking. The system is operated by one individual at an illuminated diagram, consisting of 88 levers and showing the whole of the yard trackage—11 tracks in all—with the positions of the several trains. Each lever not only places a train upon its proper track, but also effects certain positions with respect to other movements in the yards. There is no isolated action, each portion of the machine or diagram is inter-relative.

Fredericton, N.B.—It is announced at Fredericton that the construction of a dam across the St. John River at Meductic is proposed by the St. John River Hydro-Electric Company. The project has been laid before the Legislature, and its promoters claim the work will cause an ultimate expenditure of some $3,650,000. The proposed dam will cross the St. John at Meductic above Fredericton, and transmit power to Fredericton and Maryville, down the river valley, over 80 miles to St. John. The New Brunswick Hydro-Electric Company, however, opposes this plan, and having last year obtained legislation, now proposes to develop electric power from streams and lakes in St. John and Charlotte counties, with transmission to St. John for light and power purposes, including power for street railways.

Montreal, Que.—The work on the Glen bridge of the C.P.R. at Westmount will be completed this week. The new structure will double the capacity of the old one, allowing for 4 tracks where the former structure over the highway carried 2 tracks. The rebuilding of this bridge is part of the general plan for the construction of 4 tracks on the Island of Montreal between Windsor Station and the bridge at St. Annes, construction planned for and forming part of the provision for the future traffic out of the enlarged station. While the enlarged trackage will not be completed immediately, it forms part of the general plan of the terminal improvements of the Canadian Pacific in Montreal.

Ottawa, Ont.—At an early date, the Department of Naval Service will issue a publication of the results of the hydrographical surveys conducted throughout the summer under its auspices. It is stated that the report will show that a first-class harbor can be developed in the Nottaway River estuary at the southern extremity of James Bay, or the terminal gulf of Hudson Bay. Good shelter, ample room and a sufficient depth of water have been found, and there is little silt in evidence. It is believed that this intelligence will stimulate the Province of Quebec to accelerate the construction of a railway from the Nottaway River mouth to connect James Bay with Montreal and Quebec, thus providing an alternative to the marine outlet from Hudson Bay through the Straits when ice conditions in the North rendered the latter route dangerous.

Saskatoon, Sask.—The Saskatchewan Local Government Board has authorized Saskatoon debentures to the amount of $489,307, to be expended as follows: sewer mains, $7,374.35; water mains, $6,916.99; storms sewers, $19,463.46; street railway extensions, $25,000; electric light and power plant, $200,000; pumping plant extension, $10,000; sidewalks, $3,590; pavements, $19,912.32; paving approach to traffic bridge, $3,600; additional expenditure on new power house, land and buildings, $15,000; additional expenditure on police patrol and fire alarm system, $10,000; additional expenditure on exhibition biuldings, $10,000; additional expenditure on power house machinery, $85,000; waterworks meters, $25,000; water mains, $950.36; additional expenditure on intercepting sewer, $12,500; additional expenditure on force water main, $27,000; additional expenditure on sedimentation basin, $8,[illegible]

Toronto, Ont.—Plans and specifications have been completed, after several months' preparation, for the proposed North Toronto sewer system, and are now being considered by the city authorities. The estimate for the system which has been planned has been fixed at $4,144,256; and the scheme provides for the construction of two storm sewers, in addition to the regular sewers, one through the Waterworks Park, the other from Bayview Avenue to the Don River, to the proposed location of the new sewage disposal plant. The plant will consist of a standby tank for treatment of storm water, detritus tanks, Imhoff tanks, chlorinating device, sludge-drying beds, and sprinkling filters. While the purchase of sufficient land is recommended to make provision for the construction of a sewage-disposal plant capable of treating the sewage from the watersheds tributary to this system, the plant will be constructed for present requirements. Other units may be added as development demands. The total estimated cost of the plant for present requirements, including the site for future developments, is $305,900.

Victoria, B.C.—A recent report upon the work in connection with the Sooke Lake waterworks supply states that, between Cooper's Cove and Humpback reservoir, the track laying is being advanced rapidly, and the bad portion of the excavation on the pipe line near the reservoir is almost covered. A considerable amount of work remains to be done by the city at the reservoir in the shape of completing the main dam, erecting the gate house, constructing the two core dams and other work. Within two or three months this work will be completed, and from that time on the contractors for the concrete flow line and the steel riveted pressure line will proceed with their sections of the work. When the line is completed, 34 concrete trestles will have been erected between the lake and Humpback reservoir. Of these, 14 have been completed, while the concrete is being poured into the forms for the balance. Also, the steel bridge across the Sooke River is in place. The contract with the Burrard Engineering Company of Vancouver, to which was let the contract for the fabricating and laying of the steel pressure pipe line from Humpback reservoir to the city is now being prepared by the city solicitor and will be ready for signature after it has been approved by the city.

Victoria, B.C.—Constructions of the first magnitude which are progressing under the Public Works Department of the British Columbia Government, include the Court House at Prince Rupert, upon which initial work is already well advanced. The site is being levelled and a subway is now under construction. Mr. J. Cox, the local architect, has the plans for the building well in hand, and tenders will be called for very shortly. The estimated first cost of the building is between $300,000 and $400,000, but the plans are so drawn that it will be possible to make additions from time to time as circumstances warrant. The Pitt River bridge is another big undertaking. Already some important preliminary work has been done in the way of making soundings and borings. The Government has purchased the necessary steel from the C.P.R. which was used in the old bridge. The cost of this important public work will approximate $500,000. The Government office at Duncan, plans for which are in the hands of Mr. Coates, the local architect, will call for an expenditure of $40,000. The completion of the two new transcontinental railways has warranted provision by the Provincial Government in [illegible] and this year $144,000 will be expended on buildings in Cariboo and $216,000 in Skeena. Public works and buildings already in progress [illegible] ceed this year are the addition to the parliament buildings at Victoria [illegible] Burnaby, and court houses at Vernon, Nicola and Merritt.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page ?? a directory of such societies and their chief officials.

CANADIAN SOCIETY OF CIVIL ENGINEERS—TORONTO BRANCH.

The luncheon held on Thursday last by the members of the Toronto branch, Canadian Society of Civil Engineers, was attended by over 100. The speaker was Mr. J. R. W. Ambrose, newly-appointed chief engineer of the Toronto Terminal Company, to take charge of the construction of the new union station and railway viaduct. Mr. Ambrose did not enter upon any technical discussion of the project, but interested his hearers by briefly summarizing the advantageous factors maintained for the young engineer by railway work.

The branch is holding a meeting to-night (Thursday) to be addressed by Mr. J. Keele of the Geological Survey of Canada. Mr. Keele's extensive knowledge of Canadian clays is an assurance that his subject, "The Clays and Clay Industries of Canada," will be authoritative and appropriately treated. In its December 11th, 1913, issue, *The Canadian Engineer* published an article written by him on Field Examination and Testing of Clays, while synopses of his report to the Dominion Government on the pre-heating of clays and also sewer pipe and roofing the tests of Western Canada clays, appeared in the issues of February 12th and 19th respectively.

THE WELLAND SHIP CANAL.

On April 16th, J. L. Weller, C.E., Chief Engineer of the Welland Ship Canal, addressed a meeting of the University of Toronto Engineering Alumni Association, on the design and construction of the present project, which is the third to bear the name of "Welland Canal." Mr. Weller, to whom must be accredited practically the entire scheme and design, illustrated his paper by numerous slides descriptive of it and others including the Panama and the Sault Ste. Marie Canals.

In the course of his remarks Mr. Weller outlined a single-lock proposal instead of the seven locks decided upon. A single lock, he stated, would have been conducive to a great saving of time and money and would have been a quite safe proposition, but for the reason that the rock in that vicinity was not of a nature to carry the mammoth construction necessary.

At present work is well under way on the construction of the $50,000,000 project and, according to Mr. Weller's expectations, it will be completed in 4 years' time.

The Engineering Alumni Association had extended an invitation to be present to the members of the Toronto branch of the Canadian Society of Civil Engineers, many of whom responded by being present.

COMMISSION'S NEW HEADQUARTERS.

The Quebec Streams Commission has recently moved its offices in Montreal from 130 St. James Street, Yorkshire Building, to Room 803, McGill Building.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

INTERNATIONAL CONFERENCE ON CITY PLANNING to be held in Toronto, May 25-6-7, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

PERSONALS.

JAS. C. MURTON has been appointed superintendent of the Regina branch of the National Paving and Contracting Company, Limited.

THOS. ALLISON of Toronto, and formerly road superintendent of Galt, has been appointed road superintendent for Wentworth County, Ontario.

GEO. W. LEE, Mayor of North Bay, has been appointed to a seat on the Timiskaming and Northern Ontario Railway Commission, to succeed Fred Dane, resigned.

J. C. DUFRESNE, M.Can.Soc.C.E., has resigned the position of field engineer for Messrs. Cummins and Agnew, of Vernon, B.C., in order to re-establish his private practice at Penticton, B.C.

J. H. BROWNLEE, C.E., of Vancouver, gave an address there last week on "The Future of Arctic—vs. Antarctic Exploration," in which he dealt in particular with the survey work which such exploration would include.

F. A. DALLYN, B.A.Sc., C.E., Provincial Sanitary Engineer of Ontario and GEO. HOGARTH, Assistant Engineer, Department of Public Works, Ontario, have been recently

elected to membership in the American Water Works Association.

M. H. BAKER, B.A.Sc., formerly city engineer of Prince Albert, Sask., is now engaged with the Surveys Branch Department of the Interior, on the survey of roads and townsites in the Rocky Mountains and Yoho parks, in the vicinity of Banff.

SIR WILLIAM WILLCOCKS, who designed the Assuan Dam and similar regulation and irrigation works on the Nile River, Egypt, and who is now engaged upon a project to reclaim vast areas bordering on the Tigris and Euphrates rivers, is attending the National Drainage Congress at Savannah, Ga., this week, as one of the chief speakers.

ROBT. C. MUIR, until recently with Mackenzie, Mann and Co., has joined the staff of W. A. McLean, Provincial Highways Engineer for the Ontario Department of Public Works. Mr Muir, who has contributed several articles on road making to the reading columns of *The Canadian Engineer*, had a wide and varied experience in this work in Scotland, where he has held several important and responsible positions of a similar nature.

OBITUARY.

The death was reported on April 14th of SIR WILLIAM WHYTE, formerly vice-president and a director of the Canadian Pacific Railway, vice-president of the Winnipeg Electric Railway and prominent in financial affairs in Winnipeg and Western Canada. As one of the pioneers of railroading in Canada, the career of Sir William Whyte is well known to railway engineers throughout the Dominion. He was born in Scotland in 1843 and came to Canada at the age of 20. Twenty years were then spent in the service of the Grand Trunk Railway, during which he rose from the position of brakeman to that of Assistant Superintendent of the central division, extending from Kingston to Stratford.

One year after the last spike had been driven in the main line of the C.P.R., Mr. Whyte, who had entered its service several years previously, became general superintendent, and afterwards manager of all lines west of Lake Superior. He spent 11 years as general superintendent, 4 as manager of Western lines, 3 as assistant to the president, and 6 as second vice-president, with complete charge of the company's affairs between Lake Superior and the Pacific. For 1 year prior to his retirement in 1911, he was vice-president of the company.

Cement Industry in Japan.—The first Japanese cement works were established at Tokio in 1871, and the first rotary kiln was here installed about ten years ago. The plant has been extended until the output is now about 1,000,000 barrels a year.

Following the example of Quebec lumbermen and paper manufacturers, members of both trades in Ottawa district have taken steps towards the establishment of what will be known as the Canadian Forest Protective Association, a body which will be largely along the lines of that organized some years ago in the St. Maurice Valley for the protection of limits there. A committee has been appointed to proceed with a plan of organization. This will include the appointment of a manager, under whom will be four inspectors; and these in turn will direct a staff of rangers. On all commanding positions lookouts will be established to give warning in case of fire; and telephones will be installed throughout the different limits whose owners are members of the association. The railroad lines throughout the limits will also be patrolled and by all these means it is hoped to very greatly reduce the loss from forest fire, now so great.

BULGARIAN RAILWAY, BRIDGE AND HARBOR CONSTRUCTION.

An American consular report states that it is intended that Porto Lagos shall be the main harbor for Bulgarian trade in the Ægean. A railroad is to be built from Kaskovo across the Rodopo Mountains to this port, and surveys are to be begun forthwith. The Bulgarians desire to build a bridge over the Danube at Nikopoli or at Sistova, and it is hoped that a trunk line, starting from one or the other of these points and leading in an almost due southerly direction to Porto Lagos, will provide a natural outlet for Bulgaria, Roumania, southern Russia, and western Europe. This line would follow the route Nikopoli (or Sistova), Tirnovo, Stara Zagora, Mikhaelovo, Haskovo, Mastanli, Kirjali, Narli Keui, to Porto Lagos. The cost of the new section Mikhaelovo-Haskovo is estimated at $6,000,000; the distance is 109 miles. The new line is to be built by contract in four sections, a separate bid being invited for each section. There will be two tunnels, 2,500 and 2,000 metres in length respectively. The cost of the bridge over the Danube is estimated at $3,000,000, to be shared equally between Bulgaria and Roumania. It is hoped that Porto Lagos may become a Mediterranean port of the first class; $4,000,000 will be expended, and construction will be opened with public bids. The harbor will be built somewhat east of the present town. The contracts will be allotted this spring, and it is hoped that the railroad and port will be completed in three years. When Porto Lagos will be opened to commerce Varna and Bourgas will decrease in importance. It is not improbable that a special loan will be floated to cover the above project, as favorable terms might be obtained for a productive enterprise of this nature. In regard to Dedeagatch, this port is not under the present circumstances considered of much importance, and instead of a harbor a small mole is to be constructed there to facilitate loading and unloading lighters. Dedeagatch will remain an open roadstead. It is probable that the following railway lines will be constructed in the near future in Bulgaria: Schumla to Karnovit; Radomir to Dubnitza-Dzumaga; Yamboli to Kizil Agatch.

Before reoccupation of Adrianople by the Turks an important project for canalization of the Maritsa River had been discussed. The scheme would have been costly, but it is believed that by confining the Maritsa to its natural bed a sufficient depth of water could have been obtained to enable ocean steamers to ascend the river as far as Adrianople and tugs and lighters even as far as Philippopolis. The reclamation and irrigation of the rich lands on either banks of the Maritsa would have given scope for growing tobacco, rice, and cotton on a large scale, and this would have amply compensated for the original outlay. The scheme does not appear to have been definitely abandoned, and it is possible that an agreement may yet be made with Turkey, whereby it may be carried out in a modified form.

Senor Iglesiac, a Madrid electrician, has given a successful demonstration of an apparatus, of which he is the inventor, for condensing and utilizing atmospheric electricity. With the device, Senor Iglesiac lighted and extinguished at will 15 electric bulbs placed at a distance of 600 yards. Experts expressed the opinion that the discovery has great possibilities with regard to cheap production of current for industrial purposes. Early last February, William Marconi succeeded in lighting an electric bulb at a distance of 6 miles by a wireless current supplied from a 100 horsepower engine.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21604—April 6—Authorizing C.N.R. to construct Beinfait-Estevan Branch across spur of C.P.R. in N.E. ¼ Sec. 19-2-6, W. 2 M., Sask. And rescinding Order No. 20117, dated Aug. 16th, 1913, in so far as it authorized crossing spur to Western Dominion Collieries, Limited.

21605—April 6—Authorizing C.N.R. to cross and divert road between Secs. 20 and 29-29-8, W. 4 M., Alta.; rescinding Order No. 17158, dated Aug. 1st, 1912, in so far as it authorizes crossing and diversion of said road.

21606—April 6—Authorizing G.T.R. to construct siding and spur therefrom, into premises of Lord and Barnham Co., in part lots 1 and 2, plan No. 69, Berryman plan, and part of lot 14, Con. 6, Tp. Grantham, Co. Lincoln, Ont.

21607—April 3—Amending Orders Nos. 19346 and 21197, dated respectively May 19th, 1913, and January 12th, 1914, to provide that signals at crossing of industrial spur of M.C.R.R. to premises of Postum Cereal Co. of Canada, Limited and at crossing of Essex Terminal Ry. be normally clear for Sandwich, Windsor and Amherstburg Ry. Co.; and authorizing Sandwich, Windsor and Amherstburg Ry. to operate over crossing at a speed not exceeding 10 miles an hour; when trains of Essex Terminal Ry. or M.C.R.R. proceed over crossings, trainmen operate levers as required. 2. That, by agreement between Cos. interested, rights of seniority of M.C.R.R. and Essex Terminal Ry. be not prejudiced by this Order.

21608—April 7—Approving location C.P.R. station in Lot 4, Con. 11, Tp. Hinchinbrooke, Co. Frontenac, Ont., mileage 36.74.

21609—April 6—Authorizing M. and S. Co.'s Ry. to run and operate trains and cars, with passengers, baggage, express, and other traffic, over and upon line of Central Vt. Ry. between Marieville and St. Cesaire, Que., distance of 9 miles, and to use Central Vt. Ry. Co.'s passenger and freight stations, station yards, and other facilities at and between those points.

21610—April 6—Directing that expenses of an inspector, to be appointed by C.P.R. to protect traffic at crossing of Harris St., be borne and paid by city of Vancouver, B.C., pending final decision by Board after hearing.

21611—April 6—Directing that, within 60 days from date of this Order, G.T.R. install improved type of automatic bell at crossing of County Road No. 8, village of Moorefield, Ont., and thereafter maintain bell at own expense, 20 per cent. of cost of installing bell be paid out of Ry. Grade-Crossing Fund, remainder by Railway Company.

21612—April 8—Authorizing G.T.R. and C.P.R. to operate trains over crossing in West Half Lot 14, Con. 2, Tp. Trafalgar, at mileage 32.56 from Toronto, Ont., without first being brought to a stop.

21613—April 8—Authorizing C.P.R. to construct spur for Heron Bros., Sudbury, Ont., from a point on easterly limit of right-of-way, Lake Superior Div., Sudbury Sub. Div., in Lot 11, Con. 1, Tp. Cleland, Dist. Sudbury, Ont., at mileage 111.5 of said main line, Sudbury Subdivision.

21614—April 7—Authorizing G.T.P. Ry. to construct across forty-one (41) highways in District of North Alberta, Alta., mileage 0.0 to mileage 60.4.

21615—April 7—Authorizing G.T.R. to reconstruct three (3) bridges; namely, No. 336, mileage 179.99, 6th Dist.; No 334, mileage 175.86, 6th Dist., and No. 297, mileage 62.88, 5th Dist., Province of Ontario.

[illegible]—April [illegible]—Approving [illegible] and authorizing clearances as shown on plan of Standard House for track scales, subject to certain conditions. (Can. Nor. Que. Ry. Co. plan).

[illegible]—April 8—Authorizing C.N.R. to operate trains, for construction purposes only, for period of 3 months from date of this Order, over crossing of C.P.R. in Lot 101, Parish of St. Paul, Man.; provided operation be limited to hours of between 6 and 7 a.m., 12 and 1 noon, and 6 and 7 p.m.

21618—April 7—Authorizing T.H. & B. Ry. to construct spur in city of Hamilton, Ont., into lands of the Gillies Guy Coal Co., Limited, subject to and upon certain conditions.

21619—April 7—Authorizing Cedars Rapids Mfg. and Power Co., of Montreal, to take, for purpose of right-of-way of its transmission line, additional land across Lots 13 and 10, Parish of St. Joseph de Soulanges, Co. Soulanges, Que., property of Polycarpe Cholette.

21620—April 8—Granting leave to Montreal Light, Heat and Power Co., to lay 30-in. gas pipe across swamp presently under lease by G.T.R. from Dept. Ry. and Canals, Cadastral Nos. 1005, 1026, 1025, Parish of Lachine, near western end of G.T.R., Turcot Yards.

21621—April 9—Suspending, pending investigation by Board, increased rates on lumber shown in Supplement No. 51 to G.T.R. Tariff C.R.C. No. E-2318; C.P.R. Tariff C.R.C. No. E-2779; and C.N.R. Tariff C.R.C. No. E-419.

21622—April 9—Approving revised location Esquimalt and Nanaimo Ry., between mileage 71 and 76.6, Vancouver Island, B.C.; 2. Ry. Co. is authorized to divert Government Wagon Road in Lot 66, from present location at Station 3657.43 to Station 3654.8; to carry highway underneath railway at point of crossing.

21623—April 9—Authorizing Winnipeg Electric Ry. to cross, at grade, with its tracks, on Pembina Highway, spur of C.N.R. running to premises of Arctic Ice Co., and the Agricultural College, Municipality of Fort Garry, Man.

21624—April 8—Approving location C.N.O.R. station grounds at National Park, Tp. Boyd, Dist. Nipissing, Ont., at mileage 170 from Ottawa.

21625—April 9—Authorizing C.P.R. to reconstruct bridge No. 86.5, Sherbrooke Subdivision, over Magog River.

21626—April 14—Approving certain deviations and location of the Glengarry and Stormont Ry., namely,—from a connection with main line Ont. and Que. Ry., C.P.R. Lessees, in Lot 418, Parish St. Polycarpe, Que., southwesterly to point on east side River Beaudet, Lot 8, Con. 5, Tp. Lancaster, Co. Glengarry, Ont., about 1,255.5 ft. west of Interprovincial Boundary, mileage 0 to 4.96; and 2, from a point in Lot 10, Con. 2, Tp. Charlottenburg, mileage 15.04, to point on north side Ninth St., town of Cornwall, Ont., mileage 27.

21627—April 14—Amending Order No. 21559, dated March 27th, 1914, by adding clause to provide that Order be without prejudice to right of C.N.R. to construct permanent work at point in question at any time, on due notice being given to C.L.O. and W. Ry.

21628—April 11—Establishing collection and delivery limits of Dominion Express Co., in city of Lethbridge, Alta., and rescinding Order No. 21088, dated December 23rd, 1913.

21629—April 11—Extending collection and delivery limits of express companies in city of Regina, Sask.; and rescinding Order No. 14906, dated September 14th, 1911.

21630—April 9—Authorizing T.H. and B. Ry. to construct spur, in Twp. Ancaster, extending from a point on Co.'s main line across Lot 37, Con. 1, Tp. Ancaster, and running south-westerly through lands of M. J. Ireland, and across highway in said Twp., thence through lands of Mineral Springs Sand and Gravel Co., Limited, in Lot 36, said Concession, subject to certain conditions.

21631—April 11—Authorizing G.N.R., to operate trains over crossing of C.P.R. at mileage 1.4, Lot 1899, East Kootenay Dist., B.C., without first being brought to a stop; and that C.P.R. is authorized to operate over said crossing in accordance with provisions of Order No. 15941.

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ANALYSIS OF STATICALLY INDETERMINATE FLAT ARCHES

STUDIES OF THE TWO-HINGED ARCH AND ARCH WITHOUT HINGES—A UNIFORMLY DISTRIBUTED LIVE LOAD ASSUMED OVER PARABOLIC STRUCTURE.

By V. J. ELMONT, B.Sc., A.M. Can. Soc. C.E.

IT is assumed in this paper that the arches possess a vertical axis of symmetry, have a rise less than 1/7 to 1/8 of the span, and that the supports are at the same height. Further, the computation is based on the assumption that the live load can be considered as uniformly distributed as for passenger bridges, floors, roofs and similar structures; that the arch takes the form of a parabola, and that the moments of inertia do not vary significantly.

The results arrived at are also applicable to circular arches with sufficient accuracy, while for arches with considerable differences in the cross-section at various points the general formulæ for statically indeterminate structures must be applied. The formulae given here will, however, for this case, as a rule, serve as a useful guide for the determination of trial dimensions.

The types which will be considered are: (1) the arch with two hinges at the springing lines, and (2) the arch

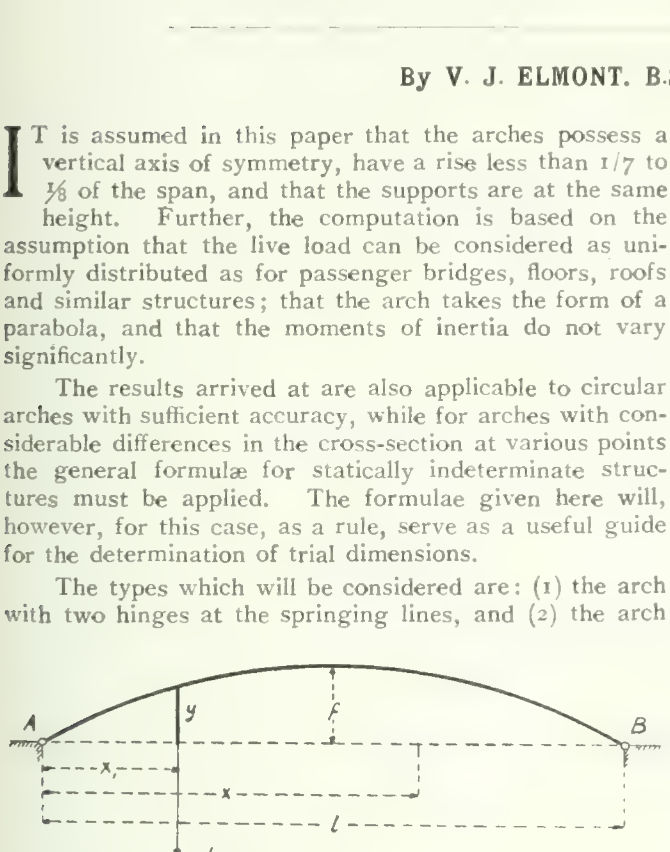

Fig. 1.

without hinges. The method followed in their analysis is the one developed by Professors Müller-Breslau and Ostenfeld.

The Two-Hinged Arch.—This arch has one statically indeterminate quantity and as such is chosen the horizontal pressure. The vertical components of the reactions are directly determinable by the statical equations and therefore not influenced by the dimensions of the cross-section of the arch nor by a slight yielding of the supports.

The equation of the line of influence of the horizontal pressure is $X = \dfrac{\delta_{ma}}{\delta_{aa}}$; δ_{ma} being the deflections of the various points, m, of the centre line of the arch, caused by a horizontal pressure of unity acting as sole load on the statically determinate auxiliary system. This system is, on account of the choice of the statically indeterminate quantity already referred to, a curved beam with one fixed and one roller end. δ_{aa} is the movement of the roller end produced by the same load.

From the general theory for statically indeterminate structures it is known that the deflections δ_{ma} can be determined as bending moments occasioned by the so-called "v" forces, acting on a simply supported beam with the same span as the arch; taking into account the assumptions mentioned in the introduction the "v" forces will be

$$v = y dx,$$

where y is the ordinate to the centre line of the arch, measured from the line between the hinges. The values of y corresponding to the various abscissæ x are given by the equation of the parabola which forms the centre line of the arch,

$$y = \frac{4f}{l^2} \times (l - x),$$

f being the rise of the arch, l the span, and x the abscissa measured from a hinge. When these "v" forces act on a simply supported beam, they will produce reactions which are equal to half the area between the arch and the line connecting the hinges, or $\frac{1}{3} fl$; whence the bending moment ($= \delta_{ma}$) at the point with the abscissa x

$$\delta_{ma} = \tfrac{1}{3} flx - \int_0^x y dx_1 (x - x_1) \text{ (see Fig. 1.)};$$

and by application of the equation of the parabola

$$\delta_{ma} = \tfrac{1}{3} flx \left[1 - 2\left(\frac{x}{l}\right)^2 + \left(\frac{x}{l}\right)^3\right]$$

or

$$\delta_{ma} = \tfrac{1}{3} fx (l - x) \left[1 + \frac{x}{l} - \left(\frac{x}{l}\right)^2\right].$$

The denominator δ_{aa} of the expression for the statically indeterminate quantity is

$$\delta_{aa} = \int_0^l y^2 dx + l i^2$$

where i is the constant radius of inertia.

By substituting for y

$$c_{aa} = 16\frac{f^2}{l^4}\int_0^l (lx-x^2)^2\,dx + h^2 l$$

$$\text{or,}\quad c_{aa} = \frac{8}{15}f^2 l + h^2 l = \frac{8}{15}fl\left[1 + \frac{15}{8}\left(\frac{i}{f}\right)^2\right].$$

Introducing

$$\alpha = \frac{1}{1 + \frac{15}{8}\frac{i^2}{f^2}},$$

the equation for the line of influence of the horizontal pressure will be

$$X = \frac{5}{8}\alpha\frac{x(l-x)}{fl}\left[1 + \frac{x}{l} - \left(\frac{x}{l}\right)^2\right].$$

The last factor does not vary considerably; for $x = 0$ and $x = 1$ the value is 1 and its maximum value, reached for $x = \frac{1}{2}l$, is 1.25. No great error will therefore arise by taking this factor as a constant, which again leads to the line of influence becoming a parabola. The mean

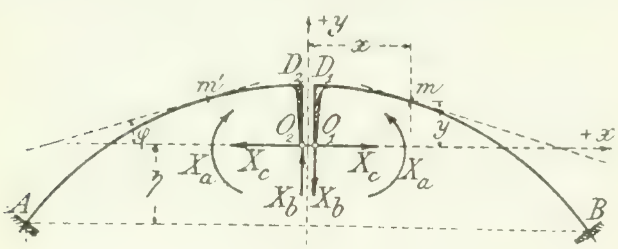

Fig. 2.

value of that factor used, is that which gives the same horizontal pressure for a uniformly distributed total load. It is calculated by either the exact equation of the approximation, whereby the equation for X attains the simple and suitable form

$$X = \frac{3}{4}\alpha\frac{x(l-x)}{lf}.$$

The line of influence of the bending moment M_m at the various points m is consequently easily derived from the general equation

$$M_m = M_{o,m} - M_{a,m}X,$$

where $M_{o,m}$ is the corresponding moment in the auxiliary system and $M_{a,m}$ is the moment produced by $X = -1$, which again is equal to the ordinate y of the point m, so that $M_m = M_{o,m} - yX$.

The equation for the line of influence of the normal pressure N_m in the arch is $N_m = -X$, on account of the assumed small rise of the arch.

By means of these lines of influence the moments and horizontal pressures for different points of the arch and varying loading conditions have been determined as follows:

For a uniformly distributed load g per unit length acting over the entire span the horizontal pressure will be

$$H = \frac{gl^2}{8f}\alpha;$$

and the bending moment at a point of the centre line of the arch at a distance x from one of the hinges and having the ordinate y,

$$M = \frac{gl^2}{8f}\cdot y(1-\alpha).$$

For $\alpha = 1$, which corresponds to the case where the shortening of the arch, due to the load on it, is so small that it can be neglected, $M = 0$ and consequently the maximum and minimum moments produced by a uniformly distributed live load have the same numerical values.

For a live load p per unit length the maximum moment at the crown of the arch is

$$\text{max. } M = \frac{1}{4}pl^2\left[\frac{1-\alpha}{2} + \alpha\left(1 - \frac{2}{3\alpha}\right)^2\right];$$

and the corresponding horizontal pressure,

$$H = \frac{pl^2}{8f}\alpha\left[1 - 2\left(1 - \frac{2}{3\alpha}\right)^2\left(1 + \frac{4}{3\alpha}\right)\right];$$

and,

$$\text{min. } M = -\frac{1}{4}pl^2\alpha\left(1 - \frac{2}{3\alpha}\right)^2;$$

with

$$H = \frac{pl^2}{8f}\cdot 2\alpha\left(1 - \frac{2}{3\alpha}\right)^2\left(1 + \frac{4}{3\alpha}\right).$$

For $\alpha = 1$,

$$\text{max. } M = +\frac{1}{108}pl^2,\quad H = \frac{13}{27}\frac{pl^2}{8f};$$

and

$$\text{min. } M = -\frac{1}{108}pl^2,\quad H = \frac{14}{27}\frac{pl^2}{8f}.$$

For $\alpha = .974$, $\left(\frac{i}{f} = .12\right)$,

$$\text{max. } M = +\frac{1}{92}pl^2,\quad H = .54\frac{pl^2}{8f};$$

$$\text{min. } M = -\frac{1}{130}pl^2,\quad H = .46\frac{pl^2}{8f}.$$

The greatest possible bending moment in the arch acts at a point, the abscissa of which lies between $x = .23\,l$ and $.25\,l$, according to the value of α.

For $\alpha = 1$, the abscissa is $x = .23\,l$, and,

$$\text{max. } M = +\frac{1}{62}pl^2,\quad H = .40\frac{pl^2}{8f};$$

and,

$$\text{min. } M = -\frac{1}{62}pl^2,\quad H = .60\frac{pl^2}{8f}.$$

For $\alpha = .974$, $x = .24\,l$ and

$$\text{max. } M = +\frac{1}{58}pl^2,\quad H = .43\frac{pl^2}{8f};$$

and,

$$\text{min. } M = -\frac{1}{67}pl^2,\quad H = .57\frac{pl^2}{8f}.$$

When one-half of the arch is loaded, between hinge and crown, the horizontal pressure is

$$H = \frac{pl^2}{16f}\alpha;$$

and the bending moment at the crown,

$$M = \frac{1}{16}pl^2(1 - \alpha).$$

The maximum and minimum moments act at the points

$$x = \frac{1}{4}l\frac{3 - 2\alpha}{2 - \alpha} \text{ and } x = \frac{1}{4}l\frac{2\alpha - 1}{\alpha},$$

and have the values.

$$\text{max. } M = -\frac{1}{64}pl^2\frac{(3 - 2\alpha)^2}{2 - \alpha},$$

$$\text{min. } M = -\frac{1}{64}pl^2\frac{(2\alpha - 1)^2}{\alpha}.$$

Thus, for $\alpha = 1$ the numerical value is $\frac{1}{64}pl^2$.

For the maximum deflection and rise at the crown Müller-Breslau has given the following approximations, the arch being loaded with live load (p per unit length) only:

$$\text{maximum deflection } \frac{pl^4}{EJ}\left[.00034 + .15\left(\frac{i}{l}\right)^2\right],$$

$$\text{maximum rise } \frac{pl^4}{EJ}\left[-.00034 + .10\left(\frac{i}{l}\right)^2\right],$$

E being the modulus of elasticity and I the moment of inertia.

The effect of the bending moments and normal forces due to an increase of the temperature of t° can readily be computed as the horizontal pressure produced by it is

$$X_t = \frac{\delta_{at}}{\delta_{aa}},$$

δ_{at} being the movement of the roller end of the auxiliary system for t° increase of temperature, δ_{at} taken positive in the same direction as δ_{aa}.

As $\delta_{at} = E J \epsilon t l$

$$X_t = EJ\frac{\epsilon t l}{\delta_{aa}} = \frac{15}{8}EJ\alpha\frac{\epsilon t}{f^2}$$

where ϵ is the elongation per unit length for one degree increase.

A yielding of the supports can be treated in a similar way; as already mentioned, it is only a movement in horizontal direction which has influence on the strains and stresses in the arch. A shortening of kl of the distance l between the hinges effects a horizontal pressure

$$X_s = EJ\frac{kl}{\delta_{aa}},$$

or by introducing the value of δ_{aa}

$$X_s = \frac{15}{8}EJ\alpha\frac{k}{f^2}.$$

The Arch Without Hinges.—This type of arch has three statically indeterminate quantities and as those are chosen the normal force X_a, the transverse force X_b, and the bending moment X_c at the crown of the arch, acting from a point O (see Fig. 2) in the axis of symmetry, so situated that each of the three equations, from which the values of the statically indeterminate quantities are calculable, will contain only one of them. Their form will then become similar to that for the horizontal pressure of the arch with two hinges.

$$X_a = \frac{\delta_{ma}}{\delta_{aa}}$$

$$X_b = \frac{\delta_{mb}}{\delta_{cc}}$$

$$X_c = \frac{\delta_{mc}}{\delta_{cc}},$$

the statically determinate auxiliary system being two curved beams with one fixed and one unsupported end.

The "v" forces for the type of arch considered here are:

$$v^a = dx$$

$$v^b = xdx$$

$$v^c = ydx,$$

which again are equivalent to the continuous loads

$$z^a = 1$$

$$z^b = x$$

$$z^c = y.$$

The distance η from the point O to the line AB (Fig. 2) is determined by the equation

$$\eta\int_0^1 Z^a\,dx = \int_0^1 Z^a\,y'\,dx$$

$$\eta = \frac{2}{3}f^\circ,$$

y' being the ordinate of the centre line of the arch measured from AB. The equation for this centre line in the system of co-ordinates, as shown in Fig. 2 with O as origin is then

$$y = \frac{4f}{l^2}\left(\frac{1}{4}l^2 - x^2\right) - \eta = f\left[\frac{1}{3} - 4\left(\frac{x}{l}\right)^2\right].$$

The deflections δ_{ma}, δ_{mb} and δ_{mc} are calculated as moments produced by the loads z, acting on a beam of length l, fixed at the centre and having unsupported ends (Fig. 3). For the left and right half of the arch respectively

$$\delta_{ma} = -\int_{-\frac{1}{2}l}^{x}(x - x_1)\,Z^a dx_1 \text{ and } = -\int_{x}^{\frac{1}{2}l}(x_1 - x)\,Z^a\,dx_1.$$

In these expressions x is the abscissa of the point for which δ_{ma} is calculated and x_1 the varying abscissa of the

load element (see Fig. 3). The formulæ for δ_{mb} and δ_{mc} are analogous to that of δ_{ma}. The denominators of the equations for X_a, X_b and X_c are

$$\delta_{aa} = \int_{-\frac{1}{2}l}^{+\frac{1}{2}l} Z^2\, dx = l$$

$$\delta_{bb} = \int_{-\frac{1}{2}l}^{+\frac{1}{2}l} x^2\, dx = \frac{1}{12} l^3$$

$$\delta_{cc} = \int_{-\frac{1}{2}l}^{+\frac{1}{2}l} y^2\, dx + li^2 = \frac{4}{45} f^2 l + li^2.$$

The equations for the statically indeterminate quantities and now known:

$$\text{for } x < 0, \qquad X_a = -\frac{1}{8}\left(1 + 2\frac{x}{l}\right)^2,$$

$$X_b = \frac{1}{2}\left(1 - \frac{x}{l}\right)\left(1 + 2\frac{x}{l}\right)^2.$$

$$\text{For } x > 0, \quad X_a = -\frac{1}{8} l \left(1 - 2\frac{x}{l}\right)^2,$$

$$X_b = -\frac{1}{2}\left(1 + \frac{x}{l}\right)\left(1 - 2\frac{x}{l}\right)^2.$$

For both $x < 0$ and $x > 0$,

$$X_c = \frac{15}{64}\frac{l}{f}\,\alpha\left(1 - 2\frac{x}{l}\right)^2\left(1 + 2\frac{x}{l}\right),$$

$$\text{where } \alpha = \frac{1}{1 + \dfrac{45}{4}\dfrac{i^2}{f^2}}.$$

The bending moments and normal forces in the arch can then be computed. The normal force N is made equal to X_c

$$N = X_c = \frac{15}{4}\frac{l}{f}\,\alpha\left[\left(\frac{x}{l}\right)^2 - \frac{1}{4}\right] = \frac{l}{f} N_1.$$

The value of N_1 depends solely on the value of the ratio $\dfrac{x}{l}$ and on the value of α. Below, N_1 is given for $\alpha = 1$ and $\alpha = .9$, and $\dfrac{x}{l}$ varying with differences of .1.

$\frac{x}{l}$ =	0	.1	.2	.3	.4	.5
α = 1: N_1	.2344	.2100	.1654	.0960	.0304	.0000
α = .9: N_1	.2110	.1944	.1480	.0864	.0271	.0000

The line of influence of the bending moment M at a point of the arch with the co-ordinates x and y has the equation

$$M = l\left(\frac{M_o}{l} - \frac{X_a}{l} - \frac{x_1}{l} X_b - \frac{y_1}{f} H_1\right) = l\, M_1\,;$$

M_o being the corresponding ordinate of the line of influence of the bending moment in the statically determinate auxiliary system. M_1 depends only on the ratios $\dfrac{x_1}{l}$ and $\dfrac{x}{l}$, where x is the abscissa of the line of influence. In the table on page 657 is given the values of M_1 for varying $\dfrac{x}{l}$ and $\dfrac{x_1}{l}$ and for $\alpha = 1$ and .9 respectively.

By the aid of these lines of influence the maximum and minimum bending moments are finally determined

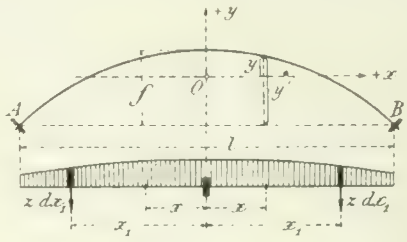

Fig. 3.

and also the simultaneously acting normal forces effected by a uniformly distributed live load p per unit length:

Maximum and Minimum Bending Moments.

	Max. M.	N.	Min. M.	N.
		$\alpha = 1$		
$\frac{x_1}{l}$ = —.5	+.0173 pl^2	.0853 $\frac{pl^2}{f}$	—.0173 pl^2	.0397 $\frac{pl^2}{f}$
—.4	+.0042 "	.0591 "	—.0042 "	.0659 "
—.3	+.0073 "	.0317 "	—.0073 "	.0933 "
—.2	+.0093 "	.0497 "	—.0093 "	.0753 "
—.1	+.0071 "	.0661 "	—.0071 "	.0589 "
0	+.0054 "	.0631 "	—.0054 "	.0619 "
		$\alpha = .9$		
$\frac{x_1}{l}$ = —.5	+.0118 pl^2	.0671 $\frac{pl^2}{f}$	—.0203 pl^2	.0454 $\frac{pl^2}{f}$
—.4	+.0026 "	.0355 "	—.0065 "	.0770 "
—.3	+.0072 "	.0283 "	—.0076 "	.0842 "
—.2	+.0103 "	.0476 "	—.0080 "	.0649 "
—.1	+.0089 "	.0661 "	—.0053 "	.0464 "
0	+.0075 "	.0686 "	—.0034 "	.0439 "

A uniformly distributed total load g per unit length gives

$$X_a = -\frac{gl^2}{24},\quad X_b = 0,\quad X_c = \frac{gl^2}{8f}\alpha,$$

and the bending moment at the various points of the arch is

$$M_{x_1} = \frac{1}{24} gl^2\left(1 - 12\frac{x_1^2}{l^2}\right)(1 - \alpha).$$

For $\alpha = 1$, there are no bending moments and consequently the maximum and minimum moments produced by a uniformly distributed live load have the same numerical values.

An increase of the temperature of $t°$ gives

$$X_{at} = 0,\quad X_{bt} = 0,\quad X_{ct} = \frac{45}{4} E\, J\, \alpha\, \frac{\epsilon t}{f^2}.$$

The influence of a yielding of the supports is readily computed by resolving the movements of the supports A and B into (1) a sinking (Δ_a at A and Δ_b at B), (2) a turning ϕ_a of the tangents at A (positive clockwise) and ϕ_b at B (positive anti-clockwise), (3) and a lengthening kl of the distance AB. The statically indeterminate quantities will then be

$$X_{au} = -EJ\frac{\phi_a - \phi_b}{\delta_{aa}}$$

$$X_{bu} = -EJ\frac{\Delta_b - \Delta_a + \frac{1}{2}l(\phi_b - \phi_a)}{\delta_{bb}}$$

$$X_{ou} = -EJ\frac{kl - \eta(\phi_a + \phi_b)}{\delta_{co}}$$

and the bending moments and normal forces in the arch are then directly computable.

VALUES OF M_1.

$\alpha = 1$

$\frac{x_1}{l}$ \ $\frac{x}{l}$	—.5	.4	—.3	—.2	—.1	.0	.1	.2	.3	.4	.5
—.5	0	—.0607	—.0640	—.0367	.0000	+.0313	+.0480	+.0473	+.0320	+.0113	0
—.4	0	+.0255	—.0090	—.0179	—.0130	—.0031	+.0054	+.0093	+.0078	+.0031	0
—.3	0	+.0142	+.0538	+.0142	—.0086	—.0187	—.0198	—.0154	—.0086	—.0026	0
—.2	0	+.0053	+.0242	+.0595	+.0130	—.0156	—.0278	—.0269	—.0174	—.0059	0
—.1	0	—.0011	+.0022	—.0181	+.0518	+.0063	—.0186	—.0251	—.0186	—.0067	0
.0	0	—.0051	—.0120	—.0101	+.0080	+.0469	+.0080	—.0101	—.0120	—.0051	0

$\alpha = .9$

$\frac{x_1}{l}$											
—.5	0	—.0627	—.0704	—.0477	—.0144	+.0157	+.0330	+.0363	+.0256	+.0093	0
—.4	0	+.0246	—.0110	—.0230	—.0196	—.0103	—.0012	+.0042	+.0049	+.0022	0
—.3	0	+.0141	+.0535	+.0138	—.0092	—.0193	—.0204	—.0158	—.0089	—.0027	0
—.2	0	+.0058	+.0259	+.0624	+.0167	—.0115	—.0241	—.0240	—.0157	—.0054	0
—.1	0	—.0002	+.0050	+.0229	+.0581	+.0132	—.0123	—.0203	—.0158	—.0058	0
.0	0	—.0041	—.0080	—.0046	+.0152	+.0547	+.0152	—.0046	—.0088	—.0041	0

PRELIMINARY ESTIMATES IN RAILROAD WORK.

SPEAKING from six years' experience as railroad engineer, Carl A. Gould, C.E., of the Northern Pacific R.R., states, in the Cornell Civil Engineer, that there are many items connected with the construction costs for which it is utterly impossible for even the most experienced to make provision at the time the first estimate is made.

With the growing tendency among the railroads to eliminate the old style of contract, containing prices for five or more classes of material, such as earth, hardpan, loose rock, shell rock, and solid rock, and place in its stead a contract containing only two classes of material, i.e., common excavation and solid rock, with the solid rock well defined and all material not coming under the solid rock definition classed as common excavation, it has left little chance for argument as to whether material encountered is of one class or another. As there is always a great difference in the prices for handling the different classes of material, naturally the contractor doing the work would feel that the man responsible for the final classification should be always on the alert to detect any difference in material and establish classification lines to be used on the final remeasured cross-section, on which is based the contractor's profit, or loss, as the case may be. As this method is practically impossible where all classes of material are encountered, the question resolves itself into one of personal opinion entirely. Now, as we are getting to a matter of dollars and cents, it is evident that it should require a man of some experience in handling material (in excavation) to arrive at what will be considered a fair percentage proportion for the work in question.

Even the most fair-minded contractors are apt to consider the engineers unfair, and on the other hand the engineers usually have good reason to think the contractors are asking too much. However, this condition is found, to a greater extent, among the smaller contractors and the engineers of limited experience. It is a fact, that it is a condition which arises on almost every piece of construction work where classification of material is made, and it behooves the engineer to become familiar with the character of the material to be moved, digging test-holes in cuts if necessary, in order that he may make a preliminary estimate which will compare favorably with the actual quantities of each class of material moved during the construction. Although the preliminary estimates are in no way binding on the railway company, this information should be furnished the contractor in order that he may place an intelligent bid, and thereby reduce the wrangling and friction with which so many of the construction jobs are closed.

There is another item which is often overlooked, and indeed difficult to determine at the outset, i.e., slides in cuts and settlement of soft ground under embankments. Allowance should be made for slides and settlements, especially where rainfall is heavy, cuts and fills deep, and ground water present. This allowance can only be approximate at best, but will be necessary when the engineer checks his final quantities with the preliminary estimates.

Over-haul is an item which is effected by all the variations in the quantities moved, and, therefore, the items above mentioned will all have an important part to play in the final over-haul quantity.

After the grading item comes the protection of the grading, of which there are many different kinds of construction. Cuts are protected by surface drains, ditches, track drains, bulkheads and retaining-wall, while in embankments the use of drains, retaining-walls, rip-rap and toe-walls are common. It requires much experience to foresee the necessity of protection against the possible conditions which may arise after the work has advanced.

Rock is usually used for the protection of the embankments, the rock varying in size from one cubic foot to five cubic yards. The most common use of rip-rap is placing it around masonry piers to prevent scouring; the river bed is here often washed out, thus letting the rock fall and requiring more rock than is contained within the slope limits.

There is also a considerable amount of rock which is lost in the handling. This, of course, would be governed more or less by the method of final measurement used, on which is based the contractor's estimate. Then, rock used for protection is an item on which a liberal allowance should be made for over-run. The writer has been on several pieces of rip-rap work and has never known the final quantity to be equal to, or less than, the original estimate. I would say that 20 per cent. is none too much to allow for over-run, from the theoretical sections, unless the contract states specifically the amount of rock to be used per unit, of length of line, which would amount to a "lump sum" bid for the work.

In tunnel costs we have something which contains a great many different items which can be figured from a knowledge of the excavation to be done, character of formation, etc., but there are many costs which cannot be foreseen, such as quicksand pockets, excess water, underground streams, and peculiar local formations, all items which it might be possible to overlook, even with the best of preliminary tests. This applies more to long tunnels than to short ones. Then in tunnels we have items which should be allowed for generously, and can only be properly estimated by the man who has had the conditions to deal with; it is impossible to use theoretical quantities without some allowance for the unexpected items of cost.

Super-structure of bridges is an item which can be accurately calculated as to weight, transportation, etc., while the foundations are always subjects requiring special study for the location in question. Anyone familiar with the different publications on bridge foundation work will note the great variation of unit costs of different bridges.

Although the condition should not exist, contractors usually look to the railroads to make good any loss on a piece of foundation work, in which unforeseen obstacles are met. As these obstacles are not figured in the original contractor's bid for the work, it may be fair for the railways to share some of the expense. Therefore, thorough testing of foundation sites should be made by the engineers, and contractors as well, in order to make an intelligent estimate of the cost of the work. Accurate preliminary estimates are accomplished only by the men of experience.

Drainage openings, such as arch culverts, pipes, box drains, and all sorts of pipe and tile drains are a constant source of trouble, both in construction and maintenance of railroad work.

Preliminary estimates should be made with a thorough investigation of the natural conditions surrounding the site of the drainage opening with a view to determining the nature of the ground, for foundation purposes, the accessibility to the site with materials, labor, and equipment, the necessity of maintaining a camp for one opening, and all local conditions which will in any way affect the location or construction of the opening. The preliminary work should be as familiar to the contractor as to the engineer, so that it will be thoroughly understood before the contract price is submitted.

Construction of the drainage openings may seem very simple at first sight, but often runs up into thousands of dollars for the simplest kinds of construction. The extra items which come up during the construction of the work and do not fall under any of the contract items, often increase the cost, of providing drainage, materially.

Protection of structures under high fills, washouts due to insufficient drainage, ground water seepage for which drainage has to be provided, stoppage of openings due to slides causing washouts, both in cuts and fills, are all items for which special provision should be made in preliminary estimates.

In Mr. Gould's own experience he has had 15,000 cubic yards of material washed from an embankment of 100 feet in length, due to an underground stream which was not detected until after the embankment material was placed and the weight forced the water back to the centre of the fill, where it broke out and caused the damage.

As a rule, the same engineer building the road-bed places the track and ballast. When ballasting, the line follows closely to the grading, it may be possible to keep the first cost estimate of ballast within the theoretical ballast limits. Often the road-bed is given a year to settle and acquire a more stable condition. This invariably requires more ballast, as it is impossible for the engineer to use a certain figure for shrinkage of embankments and have it agree exactly with the actual shrinkage which takes place. This, then, adds to the item of ballast.

In all construction work there is the item of waste which enters into the item of cost. With the very best instructions which can be given, and the best inspection which can be made, the engineer has, constantly, the item of waste to deal with.

Aside from the general construction work, there is the fluctuation of prices of materials, labor, machinery, etc. Although the railways in the West do not, as a rule, furnish materials, machinery, labor, etc., for construction work, it is not an uncommon occurrence. Small pieces of work, such as coal docks, water stations, depots, pipe culverts, are often done with railway company material.

After all, observes Mr. Gould, the engineer's life is one of continuous schooling and study along whatever line he may choose, and his value is measured by his ability to foresee conditions which will arise upon which he may plan and construct accordingly.

The Belgian Legation at Belgrade, Servia, reports that the town of Nisch proposes to raise a loan of £840,000 for canal works, construction of a line of tramways, and paving.

It is announced that Messrs. J. T. and C. Donohue have purchased all the stock of pulpwood formerly belonging to the East Canada Pulp Company, Limited, at Murray Bay, now in liquidation. The wood is in the yard booms and also uncut on the company's limits, on the Murray River and its tributaries. The purchasers have also acquired the new pulp mill

A comparison of the pulp industries in Canada and Denmark is interesting. In the little country of Denmark there are 230 pulp or paper mills. In Canada, according to the latest available statistics of the Dominion Forestry Branch, there are only 48 pulp mills in actual operation, though Canadian mills are many times larger than those in Denmark.

WATERPROOFING OF MASONRY AND BRIDGE FLOORS.

(Concluded from last week.)

Watertight Concrete Construction.—The results of laboratory experiments, supplemented by many examples from practice, have shown that watertight concrete can be made without the use of coatings, membranes or integral compounds. It is reasonable to assume that the porosity of concrete in certain cases is due to the fact that it contains small air spaces or voids throughout its mass, which are connected to each other more or less irregularly, and through which water passes, due either to the presence of the hydrostatic head or to capillary attraction. At the time of placing the concrete, some space is occupied by water carrying in suspension fine particles of cement. It is not necessary to assume that continuous capillary passages must be left in the concrete in order that as it dries the water may get out. It is probable that the excess of water passes out of the concrete in drying in such a state as to leave behind no pores through which water could again find access to the interior of the concrete or penetrate the structure.

The question of watertight concrete is then a problem of reducing the size and number of voids. Sands contain voids ranging from about 25 to 40 per cent. of the total volume of dry, loose sand. The proportions of cement to aggregate required to make a mixture of the maximum density with sands of these extreme values are about 1:1½ to 1:2½. Experience has demonstrated that mortars leaner than this are not suitable for work requiring considerable strength or density, so that the proportions used in ordinary engineering work are sufficiently rich to produce a watertight concrete, provided the aggregates possess the requisite qualities.

Samples of crusher-run limestone show 37 per cent. voids for each of two specimens, one having a maximum size stone passing 2½-in. sieve, the second passing 1¼-in. sieve. A broken stone passing a 2½-in. ring and retained on a ⅜-in. screen had 46 per cent. voids. Feret found about 52 per cent. voids in samples consisting of stones of about one size, for each of three different sizes. A similar variation in the percentage of voids with graduation in sizes of particles is found with gravel, for screened gravel of approximately one size of particles 40 per cent. to 45 per cent., for a well-graded gravel containing sand 25 per cent.

The amount of voids in a mixture of aggregate and cement is the least when the cement is just sufficient to fill the voids in the aggregate, since the cement paste itself is less dense than the coarse material of the aggregate.

A slight deficiency in cement produces a porous concrete because the unfilled voids are large enough to permit the passage of water, while properly-made concrete containing an excess of cement, though it may be of lower density than the former, is impermeable after hardening since the voids in the cement paste are too small to permit the passage of water.

Tests have failed to discover substances which, added to the concrete materials, will increase the density of the cement paste which fills the interstices between the particles of the aggregates, hence it is not believed that improvement as regards impermeability of concrete containing sufficient cement can be made by the addition of any material to the concrete mixture.

Some engineers apprehend that grading and proportioning according to ideal requirements necessitates extreme care and considerable expense, and, therefore, reject this method of obtaining watertight construction for one of the integral compounds, which is in reality based upon the same principle, or the results of which are uncertain as regards permanent impermeability and are detrimental to the strength of the concrete.

While it is true that concrete in which the amount of cement used is slightly in excess of the voids in the aggregate and in which the aggregate is so graded as to contain a minimum amount of voids, is an ideal mixture as regards density and strength, the requirements for watertight concrete do not demand the maintenance of exact proportions of this nature.

Experience has proved that materials, as supplied for large works, run uniformly enough to permit the proportioning and grading to be maintained at such a degree of excellence as to insure watertight construction at a very small expense for testing.

The following abstract from the results of laboratory tests made by the United States Bureau of Standards, Technologic Paper No. 3, are here quoted:—

These tests show that the permeability of concrete was not dependent entirely upon the quantity of cement used in proportion to the total aggregate, but depended also upon the ratio of coarse aggregate to fine aggregate. It will be observed in the case of sand No. 4, that the 1:1½:7½ proportion was decidedly more impermeable than the 1:2:4 proportion, although the former contains considerably less cement in proportion to aggregate.

Tests designed to show the effect of waterproofing materials, especially such as are added as fillers, should present a granulometric analysis of the aggregate, as comparisons are valueless without such information. It is to be expected that tests on mortar in which a sand was used having a deficiency of fine particles would show increased impermeability and increased strength upon the addition of a small amount of fine material. On the other hand, if the aggregate already contains as much fine material as it requires, addition of a fine material as waterproofing may be expected to decrease the strength and have no beneficial effect as a waterproofing material.

The method of proportioning the aggregate by mechanical analysis, which is described by Taylor & Thompson as exact and scientific, is recommended. The granulometric analysis requires a very inexpensive equipment and a complete analysis of an aggregate may be made in less than one hour's time. By its use definite data may be obtained upon which to base conclusions as to the necessity of and method of improving the concrete mixture.

In discussing the use of exterior coatings as against impermeable construction, the point is often advanced that although there is no doubt that watertight concrete can be made, the watertightness is of no avail when cracks occur in the structure.

The subject of cracking is one of design. Cracks are caused by failure to properly provide for primary stresses to which the structure is subjected, by faulty details, by settlement of foundation, by shrinkage of concrete when hardening in air, and by stresses developed in the concrete due to temperature changes.

Where concrete is to be deposited under circumstances which make it impracticable to construct watertight concrete, a special form of waterproofing should be provided.

Drainage.—The first requisite in designing any structure when water is to be kept out from the interior or from beneath, is to provide means of getting rid of the water as directly and as quickly as possible. Methods of providing drainage differ with the class of the structure.

During the construction of basements and pits, drainage can be maintained by pumping, and permanent drainage should be provided whenever a free outlet can be obtained.

Drainage of arches and culverts is provided by sloping the extrados to the back of the abutments and to the piers, placing down-spouts at piers and drain pipes behind abutments.

Drainage of retaining walls, abutments and subway walls is provided by one or more lines of drain pipes, placed at different elevations along the back of the walls.

In tunnels the extrados of the arch may be provided with sufficient slope to facilitate the flow of seepage water to the side walls. The back filling consists of porous materials, which will permit the ready passage of the water. Side-drains and connecting under-drains should be provided.

The drainage of subaqueous tunnels differs from the general problem of drainage, and is not concerned with waterproofing, in that it is a problem of handling water on the inside of the tunnel. This is usually accomplished by pumping from sumps.

The foundations of masonry reservoirs should be drained to insure the stability of the structure.

The solid floors of steel or reinforced concrete bridges may be drained by sloping the finished surface of the floor from the centre to each end, and carrying the water away back of the abutments, or the water can be carried away by downspouts at the intermediate points or supports.

Probably the commonest method of drainage solid-floor bridges is to slope the deck to one abutment or from a summit to both abutments. A continuous waterproofing layer extends over the deck and the top of the abutments and extends down over the back of the abutments to prevent the seepage of water at the bridge seat.

The surface of the waterproofing and its protection must have sufficient grade to carry away surface water. In the case of bridge floors, it is recommended that this grade be not less than 6 ins. in 100 ft. It is customary, when bridges are on sufficient grade to have the waterproofed surface at the same grade, the water being carried down over the back wall of the lower abutment, where drainage is provided by coarse backing and open-joint drains.

An objection to this method of drainage is made by some who find that in the spring, when the surface ice and snow melt and the filling back of the abutments is still in a frozen condition, the water does not escape freely, but accumulates and eventually seeps through at the end of the bridge and flows over the face of the abutment. Another objection is that in bridges having supports at curb lines and in the middle of the street, whether of flat slab construction or of steel troughs filled with concrete, cracks in the waterproof covering and in the concrete filling are likely to appear where joints are not provided over these supports, and where joints are provided, trouble is likely to be experienced in preventing the seepage of water.

When the troughs of steel bridges run transversely to the track and the filling in the troughs is omitted, the individual troughs may be drained through outlets in the bottom of the troughs into a drainage gutter suspended beneath the deck. These gutters may empty into pipes which run through the abutments and empty outside the embankment. Difficulty is found in obtaining a seal between the waterproofing and the drain pipe or opening in the trough.

When the troughs of solid floor steel bridges run parallel with the tracks, the water is usually carried over the abutments as in the concrete floor bridges.

A method sometimes used on solid-floor bridges in which the deck is filled up above the top of the steel with cement or bituminous concrete is to divide the floor of the bridge into rectangular sections, each of which is sloped to a drain pipe at one corner which carries the water through a down-spout at one of the supporting columns.

Much difficulty has been experienced with all types of waterproofing on steel bridges in preventing the leakage of water along the webs of girders. Although the concrete filling of the deck may be carried up above the top of the rail and great pains may be taken in providing a joint with a waterproofing material between the girder web and the concrete, leaks usually develop along the girder.

Several bridges have been built in which a special flashing angle or Z-bar extending the full length has been riveted to the inside of the girder to prevent the flow of water down the web of the girder. By carrying the concrete filling up underneath the outstanding leg of the flashing angle or Z-bar an efficient flashing is obtained. Good results have been obtained in the case of through girder bridges by carrying the concrete filling up under the top flange of the girder.

In considering the conclusions presented in Bulletin 64 in regard to reinforcing over supports, the following remarks of President Armstrong, of the Western Society of Engineers, are of interest:—

In large railroad structures it is impracticable to reinforce concrete so that there will be no cracks over a line of supports; good engineering would not permit such practice. It would be better to allow the concrete to crack or to leave a joint there, and then provide some means of keeping out the water. In the lighter structures, it is practicable to reinforce the concrete so that the reinforcement will prevent cracks at supports.

A joint in the waterproofing which will allow of movement of the ends of adjacent spans at supports is believed to be necessary. The use of a metal flashing between concrete slabs over joints has been used.

When the steel troughs run transversely to the track, a slight movement under traffic is to be expected at the connection of the troughs to the girders. Consequently, it would seem necessary to keep the water away from these connections by means of flashing and providing sufficient slope toward the centre of the floor, adjacent to the girders.

Figures show methods of waterproofing various structures.

Conclusions.—(1) Watertight concrete may be obtained by proper design, reinforcing the concrete against cracks due to expansion and contraction, using the proper proportions of cement and graded aggregates to secure the filling of voids and employing proper workmanship and close supervision.

(2) Membrane waterproofing, of either asphalt or pure coal-tar pitch in connection with felts and burlaps, with proper number of layers, good materials and workmanship and good working conditions, is recommended as good practice for waterproofing masonry, concrete and bridge floors.

(3) Permanent and direct drainage of bridge floors is essential to secure good results in waterproofing.

(4) Integral methods of waterproofing concrete have given some good results. Special care is required to properly proportion the concrete, mix thoroughly and deposit properly so as to have the void-filling compounds do the required duty; if this is neglected, the value of the compounds is lost and their waterproofing effect destroyed.

Careful tests should be made to ascertain the proper proportions and effectiveness of such compounds.

Integral compounds should be used with caution, ascertaining their chemical action on the concrete as well as their effect on its strength; as a general rule, integral compounds are not recommended, since the same results as to watertightness can be obtained by adding a small percentage of cement and properly grading the aggregate.

(5) Surface coatings, such as cement mortar, asphalt or bituminous mastic, if properly applied to masonry reinforced against cracks produced by settlement, expansion and contraction, may be successfully used for waterproofing arches, abutments, retaining walls, reservoirs and similar structures; for important work under high pressure of water these cannot be recommended for all conditions.

(6) Surface brush coating, such as oil paints and varnishes, are not considered reliable or lasting for waterproofing of masonry.

PROGRESS OF STREAM MEASUREMENTS IN WESTERN CANADA.

THE general scheme of stream measurement being carried out under the direction of F. H. Peters, C.E., Commissioner of Irrigation for the Department of the Interior, was outlined in *The Canadian Engineer* for November 3rd and 10th, 1910. The article referred to the report of P. M. Sauder, C.E., Chief Hydrographer. The department had been formed as a separate organization in the spring of 1909, with headquarters at Calgary. The article concerning it dealt with the organization, scope of the work, methods of measurement, etc. The investigation received further attention in our issue of May 30th, 1912, which issue contained an abstract of the progress report by Mr. Sauder, describing the various methods in use for determining discharge, mean velocity, etc.

The progress report for 1912 has just been issued and from it the following data, greatly condensed, has been extracted:—

Scope of Work.—The chief features of the stream measurement work are the collection of data relating to the flow of surface waters and a study of the conditions affecting this flow. Information is also collected concerning river profiles, the duration and magnitude of floods, irrigation, water-power, storage, seepage, etc., which may be of use in hydrographic studies.

This information is obtained by a series of observations at regular gauging stations which are established at suitable points. The selection of sites for these gauging stations and their maintenance depend largely upon the physical features and needs of the locality. If water is to be used for irrigation purposes the summer flow receives special attention; where it is required for power purposes, it becomes necessary to determine the minimum flow; if water is to be stored, information is obtained regarding the maximum flow. In all cases the duration of the different stages of the streams is recorded. Throughout the country gauging stations are maintained for general statistical purposes, to show the conditions existing through long periods. They are also used as primary stations, and their records in connection with short series of measurements will serve as bases for estimating the flow at other points in the drainage basin.

In the spring of 1912, field operations were commenced with 132 regular gauging stations on various streams in Alberta and Saskatchewan and 30 on irrigation ditches, and at present the regimen of flow is being studied at 139 regular gauging stations on streams and 40 on irrigation ditches. Winter records, which are so valuable for power investigations and municipal water supplies, have been given special attention latterly and records have been secured on almost all the important streams in these provinces during the past winter.

Organization.—The methods of carrying on the investigations were similar to those of previous years. Local residents were engaged to observe the gauge height at regular gauging stations. These observations were recorded in a book supplied by the department, and at the end of each week the observer copied the week's records on a postal card which was sent to the chief

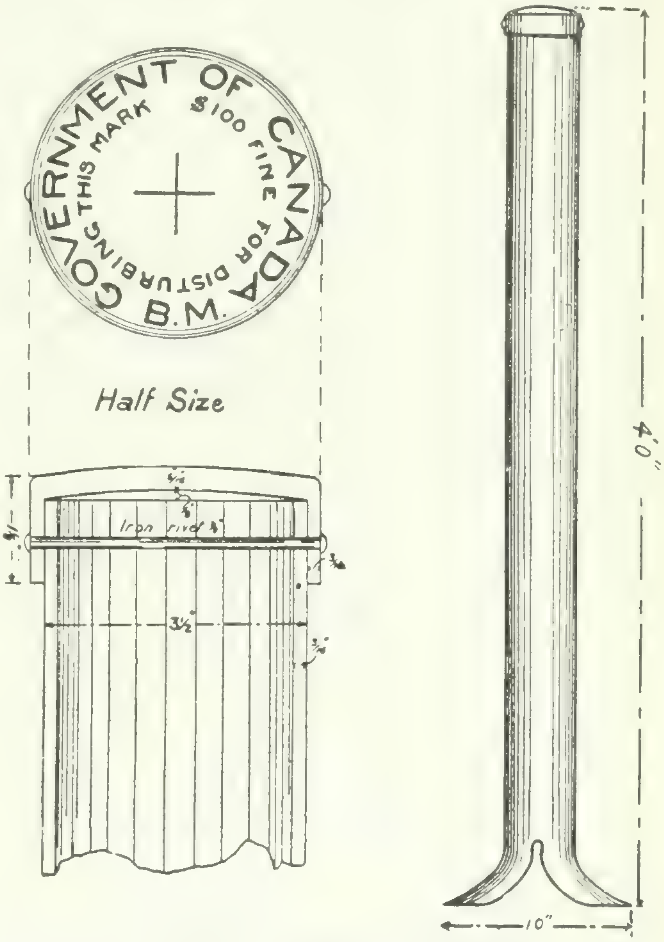

Fig. 1.—Permanent Benchmark Constructed of Iron, Adopted by the Irrigation Office.

hydrographer by the first convenient mail. The district hydrographers made regular visits to the gauging stations, usually once in every three weeks. On these visits they examined the observer's records, made discharge measurements and collected such information and data as would be of use in making estimates of the daily flow at the station. The results of the gaugings were transmitted by a postal card to the chief hydrographer. In the office these reports of the gauge height observers and the hydrographers were copied from the postal cards to regular forms and filed. At the close of the open season, some of the hydrographers returned to the office and assisted in the final computations and estimates of runoff. Gauge height-area, gauge height-mean velocity, and gauge height-discharge curves were plotted and rating tables constructed. Tables of discharge measurements, daily gauge height and discharge, and monthly discharge were also compiled.

The regular staff consisted of the chief hydrographer, ten assistant engineers, one recorder, one computor and one clerk. In order to overtake back work, three junior engineers were also employed for a portion of the year. The territory was divided for administrative purposes, into nine districts, viz., Banff, Calgary, Macleod, Cardston, Milk River, Western Cypress Hills, Eastern Cypress Hills, Moose Jaw, and Battleford. In each district there was an engineer and while in the field he had an assistant, and was equipped with the necessary gauging and surveying instruments. The tenth engineer was employed at rating meters and office work during the summer.

As winter records are of no value on a great many of the smaller streams the number of gauging stations maintained during the winter months was much less than during the summer, and by re-arranging the districts five engineers were able to do all the field work during the winter. The other five engineers and the three juniors have compiled the records.

Banff District.—This district included ten regular gauging stations. As the district has been in operation for some time, and several new stations had been established after a thorough reconnaissance in 1911, very few changes were made in the Banff district during 1912. In a few cases the conditions have been so unfavorable that gauge readings could not be obtained all winter, but in almost every case discharge measurements have been made regularly at intervals of about two weeks during the whole year at all of the stations excepting Forty-mile Creek, which was not established until July 31, 1912, and Jumpingpound Creek, which was not included during the winter months. During the year a large number of miscellaneous gaugings were made.

Owing to the comparatively low flow of Bow River during the winter months, the Calgary Power and Transmission Company, which has a power plant in operation at Horseshoe Falls and is building another plant at Kananaskis Falls, found it necessary to store water to tide over this period, and during the spring of 1912 built a dam on Cascade River near the mouth of Devil's Creek to increase the storage capacity of Lake Minewanka. The dam was completed before the high water period in June and the reservoir was therefore filled last summer (1912) and emptied during the winter. As this dam backs water up Devil's Creek the gauging station on this stream had to be abandoned, and it must be borne in mind, when using the records of flow of Cascade and Bow Rivers below Lake Minewanka reservoir, that after the first of June, 1912, the flow is affected by the operation of this reservoir and the records do not represent the true natural flow of the stream.

The town of Banff takes its domestic water supply from Forty-mile Creek, and as its requirements are gradually increasing it was thought advisable to take records of the flow of this stream. It is, however, impossible to get an observer above the intake of the waterworks and the station had to be established below the intake. The records, therefore, only represent the surplus flow which is not used by the town, and the consumption of the town has to be added to obtain the total natural flow of the stream.

Bath Creek is an important tributary of Bow River but no regular station has been established on it as it has been impossible in the past to secure an observer. This difficulty may not exist in future, and in such a case, a regular gauging station will be established.

Records will also be taken in future of the flow of Louise Creek, which is used by the Canadian Pacific Railway Company to develop power for use at the Lake Louise Chalet.

Further power development of Bow River depends very largely on the creation of storage reservoirs, to conserve flood water for use during the winter months, and during 1912 the Water Power Branch continued and completed its investigations of the upper regions of Bow River drainage basin. Whether any new stations are established in this district or any of the present ones are abandoned will depend largely on the report of the Water Power Branch and it is therefore awaited with much interest.

Calgary District.—This district included 18 regular gauging stations. It is the same as in 1911, except that a regular gauging station has been established on Highwood River above the mouth of Pekisko Creek. While this station was established primarily for statistical purposes, its records will probably be of considerable value in determining the possibilities of power development in this stream.

There were no special developments in this district during 1912, but as the canals being constructed by the Canadian Pacific Railway Company, the Southern Alberta Land Company, and the Alberta Land Company, are nearing completion, the value of the records of stream flow becomes more apparent. The first company will no doubt require more than the average low water flow of Bow River, and the other two depend entirely on the high water and flood discharge of the river for their water supply. Not only is it necessary to know the discharge of the river at these stages but also the duration of each stage.

The Southern Alberta Land Company and the Canadian Pacific Railway Company both anticipate the diversion of water throughout the whole of the open flow period, and anticipate a diversion that will approach the whole of the flow of the river so that the conditions of diversion for these large companies are becoming critical.

These problems cannot, however, be satisfactorily solved without records of stream flow covering a period of several years, and now that there are nearly five years' records of the flow of Bow River at Calgary approximate estimates can at least be made.

In designing a dam it is essential to know the maximum flood discharge of the stream in order to provide the necessary spillway to pass it without injury to the structure or adjoining property. During the past year all available data regarding the floods on Bow River was collected and estimates of the maximum flood discharge at different points were made.

Macleod District.—This district included 26 regular gauging stations. As it had been thoroughly reconnoitred during previous years it was not necessary to establish any new stations on rivers or creeks during 1912. As, however, some of the smaller streams in the Crow's Nest Pass are being used for domestic and industrial water supplies it will probably be advisable to establish regular gauging stations on some of these during the coming year.

Owing to the abundance of coal in this district, power is not very expensive and water power has not been developed. There are no great power possibilities but there are good opportunities for developing a small amount of power very cheaply. One very serious drawback to water power development is the absence of suitable sites for reservoirs to store water to augment the winter flow.

Irrigation is not generally required in this district and the developments in that line are therefore not very great.

Cardston District.—This district included 13 regular gauging stations.

In August, 1912, an arrangement was made with the United States Geological Survey by which regular gauging stations on St. Mary and Milk Rivers would in future be maintained jointly, each bearing half the cost of construction and maintenance. To get more accurate and satisfactory records it was decided to re-locate the stations at the best sites near the International Boundary and install automatic recording gauges.

There are only a few irrigation ditches in this district and the hydrographer therefore makes any inspections of these that are necessary. Unless urgent, they are usually made in the late summer or early fall when the streams are low and almost stationary, and need not be gauged as often as usual.

Milk River District.—The number of regular gauging stations in this district is comparatively small, 10 in number, but owing to shifting conditions at every one of them, it is necessary to make frequent gaugings in order to get reliable records, and as the distance between the stations is above the average the hydrographer cannot cover a larger district. The arrangement with the United States Geological Survey also includes gauging stations on Milk River and the South Branch of Milk River in this district.

Western Cypress Hills District.—This included 36 regular gauging stations.

Many of the ditch owners do not realize the value of records of the water used by them, and it has therefore been impossible to get good records on the ditches, but these will gradually improve, for, as irrigation increases, the irrigator will find the records very useful and will be only too glad to co-operate with the department in taking them.

This district includes a great many regular gauging stations on very small streams, but as every bit of available water will eventually be used for irrigation purposes, records on these are valuable.

While this is a rather large driving district, it can be covered satisfactorily except during the spring time. There is usually quite a large snow-fall in the hills during the winter and this usually runs off very quickly when spring opens up and the streams become quite high for a short time. Sometimes rains follow and keep the flow up, but not always, and the irrigators depending on high water and flood discharge of the stream should fill their reservoirs at the first opportunity. The records during early spring are therefore of considerable importance, but as the freshets are of short duration and travelling is difficult at that time, it is impossible for one hydrographer to cover the district properly. The hydrographer should be in the field on or shortly after the middle of March. This has not always been possible, owing to the fact that the fiscal year ends on the 31st of March and funds were not available. Provision should therefore be made in future estimates so that two hydrographers can be placed in this district during the spring and so that they can start field work about the middle of March.

Winter measurements would be of little value in this district and none have therefore been taken.

Eastern Cypress Hills District.—This district included 41 regular gauging stations. Beaver dams have become so numerous on some of the streams in it that it is difficult to get satisfactory records of the flow.

Moose Jaw District.—This district included 16 regular gauging stations.

The number of regular gauging stations in this district is comparatively small, but owing to the long distances between gauging stations and the importance of some of these it is impossible to increase the number.

There are now eight dams on Moose Jaw Creek in connection with domestic and industrial water supplies, and at least one other is contemplated. There is also about the same number of dams on Souris River. Though small and of an inferior quality, the water supply from these streams is very valuable. In order to intelligently administer the regulations and deal with new applications for water supply it is absolutely necessary to obtain continuous records of the flow of these streams at different points, and they are therefore being given special attention.

Winter records were taken only on Moose Jaw Creek near Moose Jaw, Qu'Appelle River at Lumsden, and South Saskatchewan River at Medicine Hat during January, February, and March, but were also obtained on Souris River at Estevan, and Swiftcurrent Creek at Swift Current in December. The station at Medicine Hat was included in the Macleod district, and the others in the Battleford district during January, February and March, but in December were a part of the new Moose Jaw district, which includes part of the old Battleford district.

Battleford District.—This district included 6 regular gauging stations. While there was no immediate use for records on the streams in this district when it was first started, the records are now of very great value to the Department of Public Works in their study of the North Saskatchewan River for navigation purposes, also to the Water Power Branch of this department and others interested in power development. There will be a good market for power in central Alberta, and many parties have been investigating the favorable water power sites and are awaiting records of the flow of the streams west and north of Edmonton.

During the winter almost continuous records were taken at all the regular gauging stations in this district. Those at Battleford, Prince Albert and Saskatoon were included in the new Moose Jaw district during December and the remainder in a new district called the Edmonton district. The Edmonton district included Red Deer River at Red Deer, North Saskatchewan River at Edmonton, and Athabasca River and its tributaries.

Bench Marks.—When the stream measurement work was first started, the gauges were usually referred to a bench mark on a wooden stake or stump of a tree. These were easily shifted or destroyed and were not satisfactory. In 1911, an iron bench mark of the type used by the United States Geological Survey was adopted, and was established as 62 regular gauging stations. During the past year, about 45 more were established and now almost all the gauges are either referred to a bench mark on a concrete pier or other permanent structure, or to one of these iron bench marks. Whenever an opportunity is afforded these are tied to the Canadian Pacific Railway or Dominion Government levels, to determine their elevation above sea level, and are therefore also a convenient reference for local levelling operations.

Fig. 1 shows the type and details of the permanent iron bench mark which is used. It is made of a piece of 3½-inch wrought iron pipe which is split at the bottom and expanded to a width of ten inches in order to anchor the tube solidly in the ground. The top is covered by a cap cast out of brass, or preferably aluminum bronze (10% Al. and 90% Cu.), which is secured to the top of the pipe by a long iron rivet. The inscription on the cap is cast in sunk-in letters giving a smooth surface to the cap. All

the exposed surfaces of the iron pipe are given a good coat of a first quality rust-resisting paint, and the bench mark is set with six inches projecting above the ground.

The brass cap for the iron bench mark may be modified and made with a stem about three inches long projecting on the under side which can be cemented into a drill hole in solid rock or masonry, to form a permanent and convenient bench mark.

Office Work.—The reports of the gauge height observers and the hydrographers are transmitted to the office by postal cards. These are copied to office forms and filed in a cabinet, which is carefully indexed and where they can be referred to at any time without trouble. As the engineers complete their computations, the results are entered on convenient forms and filed in the same cabinet.

A cabinet made up of four styles of drawers is used for filing the records. The top section is used for filing the gauge height books of the observers and the current meter note books of the hydrographers. The gauge height books are filed alphabetically according to the names of the gauging stations, while the current meter note books are filed alphabetically, according to the names of the hydrographers. The next section contains the postal cards sent in by the observers and the hydrographers. Both of these are filed alphabetically, according to the names of the gauging stations. The third section is made up of map drawers and contains the gauge height-area, gauge height-mean velocity and gauge height-discharge curves, and plotted cross-sections which are filed alphabetically, according to the names of the gauging stations. The same section contains the maps showing the outlines of the drainage basins, filed numerically, according to the number of the sectional sheet. The rating curves for the current meters are also filed in this section numerically, according to the office numbers of the meters. The bottom section of the cabinet consists of letter size pockets, alphabetically arranged for each gauging station. The tables of gauge heights, discharge measurements, daily gauge height and discharge, monthly discharge, a description of the station, and memos of any changes are filed in these pockets. The different rating tables for each meter are also filed numerically in this section and another drawer contains the monthly reports of the meteorological service.

The copying and filing of the reports of the gauge height observers and the hydrographers is entrusted to the office recorder. While doing this he must carefully examine all records to see that there are no errors, and where there are doubtful or impossible records it is his duty to have the data corrected or ascertain the cause of the unusual condition. He also makes out the pay list for the observers and conducts the correspondence relating to the records.

All computations are checked before being used or published. For this reason, as far as possible, men with some technical education, or students in science, are engaged as helpers. The gaugings are computed by the helper and his work is checked by the hydrographer. In some instances where there is a great deal of driving and camping out, the hydrographer cannot secure a helper who can compute discharges, and in that case he computes the discharges himself and his computations are checked in the office.

Gaugings of the flow under ice are usually made by using the multiple point method, and vertical velocity curves have to be plotted to determine the mean velocity in the vertical. The computation by this method is long and tedious and cannot be done by the hydrographer in the field. There are, therefore, a great many computations to be made in the office and the services of a computer are required.

Future Work.—The stream measurement work will be continued during the coming year in all the old districts; and every effort will be made to extend the territory covered, but the scope of the work is, of course, limited by the appropriation and staff available.

There are a number of important streams which rise in the mountains west of the Calgary and Edmonton Branch of the Canadian Pacific Railway. With the advent of railways, industries will soon be started in this district and the water supply will be an important factor. During the coming year it is proposed to have a hydrographer make a thorough reconnaissance of this district and make a study of the water supply, particularly to get records of the flow of the North Saskatchewan River and its tributaries. No doubt there are possibilities of water power development in this district, and records of stream flow will be wanted.

During the past year some information has been secured regarding the flow of Athabasca, McLeod and Pembina rivers. It will be impossible to secure observers wherever desired, but it is hoped during the coming year to make a careful reconnaissance of Athabasca River and its tributaries and establish regular gauging stations wherever the value of the records will warrant the expense of obtaining them. As elsewhere, our investigations in this district during the past year show that the minimum flow which occurs during the winter is much below the general expectation, and as there is a large number of possible power sites on this stream winter records are of much value, and special efforts will be made to get records at the more important points during the next winter.

Fortunately, excessive floods do not occur very frequently on the streams in Alberta and Saskatchewan, but, nevertheless, it is most important that these should not be under-estimated when designing dams, headgates, bridges, and other works on the streams. Not only does their destruction cause heavy loss to the owners of the structures but the lives and property of many other people are endangered. As above intimated, special studies of the maximum floods on Bow and North Saskatchewan Rivers at certain points were made during the past year. In future this subject will be given special attention, all available data will be collected, and the estimates tabulated in convenient form for use in designing structures at different points on each large stream.

It might not be amiss to refer to the importance of studying the winter flow of some of the smaller streams in the more thickly populated districts. Domestic and industrial water supplies have been installed to take their supply from streams which, judging from their open water flow, would provide an ample supply at all times. In several instances waterworks have been installed without sufficient knowledge of the winter flow, with the result that the supply proved to be inadequate during the winter. When the supply is from open streams this can very often be overcome by creating storage reservoirs at a nominal cost, but in cases where the supply is from springs there is seldom any remedy. As many of the towns on the prairie are dependent for their water supply on streams with very small flow during the winter months, it is most important that they should know before designing their works exactly what that flow is, so that the scheme will include the necessary storage facilities. The railways are also becoming perplexed as to how to get enough water in some localities to operate their trains during the winter

months and during the past winter had, in some instances, to haul water for very long distances, owing to the failure of their water supply at certain tanks. Records of the discharge of all the streams in these localities, even though very small, are very valuable during both summer and winter.

Many engineers make their estimates of stream flow from precipitation records. It should, however, be pointed out that precipitation records gathered at a few isolated points are of very little value in estimating the probable discharge of the streams in Alberta and Saskatchewan and very often are misleading. The physical features and the precipitation are so varied within the same drainage basin that no reliable estimates can be made. Streams, such as Bow River, for instance, very often have a comparatively large run-off during a comparatively hot, dry summer, due to the fact that a much larger quantity of snow and ice is melted in the mountains in a hot, dry summer than in a cold, wet summer. In a cold, wet summer the precipitation in the mountains often falls as snow and is stored instead of coming down to still further swell the already high streams. This same condition is found on the North Saskatchewan and all other large streams whose main sources are in the mountains. It is, for instance, impossible to estimate the probable discharge of the North Saskatchewan River at Prince Albert from precipitation records and the only reliable data to use are the records of stream flow.

To arrive at anything approaching a reliable estimate of the flow of a stream at different stages and the duration of those stages, a series of continuous records of discharge extending over a considerable period is absolutely necessary. George W. Rafter, in Water Supply Paper No. 80, published by the United States Geological Survey, says: "Further, it can be stated that for records from twenty years to thirty-five years in length the error may be expected to vary from 3.25 per cent. down to 2 per cent., and that, for the shorter periods of five, ten and fifteen years the probable extreme deviation from the mean would be 15 per cent., 8.25 per cent., and 4.75 per cent. respectively.

Mr. Rafter says, further, that with less complete records "Mr. Henry reached the conclusion that at least 35 to 40 years' observations are required to obtain a result that will not depart more than 5 per cent. from the true normal. The average variation of a 35-year period was found to be 5 per cent., and for a 40-year period 3 per cent."

The records of this office do not extend over a period of more than five years on any stream, and during that period interruptions have occurred, due to lack of funds and staff. Proper provision should be made so that this work will not in future be subject to these interruptions.

The water supply is one of the most important resources of a country, and an accurate knowledge of the flow of water in nearly all important streams is essential for the solution of many problems in connection with navigation, water-power, irrigation, domestic and industrial water supplies, sewage disposal, mining, bridge building, river-channel protection, flood prevention, and storage for conservation of flood waters. The records are being used quite extensively now by engineers and the field of operations should be extended to include other parts, if not the whole of Canada.

The work is in charge of P. M. Sauder, C.E., Chief Hydrographer. His first assistant since January 1st, 1913, has been G. H. Whyte, B.A.Sc., and his second assistant, G. R. Elliott, B.A.Sc.

PRESENT DAY WATER FILTRATION PRACTICE.

THE two methods of water filtration; namely, by slow sand and by rapid sand filters, English and American types respectively, are traced in their development, are compared as to their relative applicability to meet varying sets of conditions and are discussed as to the features of operation upon which the efficiencies of both depend, in a paper to be presented by Mr. George A. Johnson, Consulting Engineer, New York City, at the coming meeting of the American Water-Works Association in Philadelphia. The writer dwells also to some extent upon the questions of comparative cost of filtered water as obtained by the two methods.

According to Mr. Johnson, the first municipal water filter was built at London 85 years ago. It was built to perform only the functions of a mechanical strainer for the removal of suspended matter. At that time the two most important water-borne diseases (typhoid fever and cholera) had not then been discovered, and the germ theory of diseases was not advanced until some 20 years later. The first official recognition of water filtration as a means of reducing the dangers in impure drinking water took the form of an Act of Parliament in 1852, which made compulsory the filtration of the entire water supply of the metropolitan district of London.

This filter, as well as all those which followed during the succeeding 50 years, was of the slow sand type. After considerable scientific investigation, particularly in Germany, this type found its way to America and appeared at Poughkeepsie, N.Y., about 1875, as the first municipal water filtration plant in America. Its adoption was slow, however, and, in 1890, only 35,000 people in America were being served with water so filtered.

A patent for a process in which a coagulant was added to the raw water before filtration was granted in 1884, and with the use of coagulating chemicals the mechanical or rapid sand filter developed.

Up to January, 1914, some 30 slow sand filtration plants were put in operation, or were at that date under construction in the United States. They have a daily filtration capacity of 840,000,000 gallons and are designed to serve a total population of 5,500,000. Of this population 73% is served by the filter plants installed in eight cities, while the remaining population is widely scattered through some twenty cities.

Mr. Johnson's paper takes into consideration the operation and efficiency of the plants at Lawrence, Mass.; Albany, N.Y.; Washington, D.C.; Philadelphia, Pa., and Pittsburgh, Pa., showing the difficulties under which filters of this type are obliged to work when called upon to treat muddy waters. It is noted that in every instance, with the sole exception of Lawrence, the original design has been improved upon and the preparatory treatment of the work made more complete. This preparatory treatment consisted in some instances of roughing filters, the use of coagulant, or both, while at practically all slow sand filter plants in the United States the final filtered product is sterilized with hypochlorites. Mr. Johnson states that with the exception of Lawrence, Providence and New Haven, it is becoming difficult to locate the slow sand filter plant which does not in some important respect depart from the original ideas of what constituted that system of water purification or which does not in some way make use of certain inherent ideas upon which are based the rapid sand system of water filtration.

Since the installation of the first municipal rapid sand filtration plant at Somerville, N.J., in 1885, upwards of 450 municipal filter plants of this type have been built or are now under construction in the United States. Those operating have a daily capacity totalling 1,745,000,000 gallons and approximately 12,000,000 people are being supplied with water so filtered.

Between 1890 and 1900 there was much scientific investigation into the merits of the new process. These studies were in no small measure responsible for the wonderful growth of rapid sand filtration during the past 15 years, as the theory of the process was thoroughly worked out and the idea placed upon solid footing.

The type of construction changed abruptly about 1900, rectangular concrete tanks frequently replacing the circular wooden or steel tanks formerly used. The new type necessitated the use of compressed air to agitate the sand layer while washing the filter and later the application of wash water at high velocities. These methods became general, supplanting the mechanical stirrers and wash water at low velocity used in the old type of rapid sand filters, and from which they had derived the name of mechanical filter.

Among the 450 plants mentioned above, the largest are situated at Little Falls, N.J.; New Orleans, La.; Cincinnati, Ohio; Louisville, Ky., and Columbus, Ohio, the respective daily capacities being 32, 44, 112, 36 and 30 million gallons daily. Mr. Johnson's paper describes the experiences of these five plants.

Relative Cost of Slow Sand and Rapid Sand Fltration.—Construction.—In discussing the cost of building water filtration works of the slow sand and rapid sand types, respectively, Mr. Johnson gives consideration only to those items referring to the filter plant proper. Cost of land, pumping machinery, outside connecting piping, intakes, etc., in fact everything outside the filtration plant proper, is not considered. The following is a summary of this portion of his paper:

For slow sand filter costs the items will include the necessary filter buildings and filters with all appurtenances, all inside piping, sand handling apparatus, preliminary sedimentation basins, preliminary filters and appurtenances and clear water reservoirs.

For rapid sand filter costs the items will include the filter buildings and filters with all appurtenances, all inside piping, filter washing apparatus, coagulating and clear water basins. Thus a fairly good idea may be had of the relative cost of building purification plants of the two types.

It is true that, on account of the much greater area required, the cost for land is far greater in the case of slow sand filtration systems than for rapid sand systems. Roughly, other things being equal, land will cost twenty times as much for a slow sand filter installation as for a rapid sand plant. Furthermore, in large projects, it is often difficult conveniently to locate a site for slow sand filters, while for a rapid sand filter plant it is a relatively easy matter as a rule. If it is necessary to go a long distance in locating an extensive and suitable area of land for a slow sand filter site there is incurred a large expense for a conduit to bring the filtered water to the city. This is very rarely necessary in the case of rapid sand filter projects. So that, in studying the comparative figures which follow, it must distinctly be borne in mind that the costs given for slow sand filter installations are really low, since the important considerations just mentioned are not charged against them.

Cost of construction of slow sand and rapid sand water filtration plants.

City.	Kind of sand filters.	Present daily filtering capacity.	Approximate cost per million gallons daily capacity.
Albany, N.Y.	Slow	20,000,000	$20,000 (a)
Pittsburgh, Pa.	Slow	200,000,000	26,000 (a)
Philadelphia, Pa.:			
Torresdale	Slow	250,000,000	37,700 (a)
Upper Roxborough ..	Slow	28,000,000	29,800
Lower Roxborough ..	Slow	17,000,000	26,300 (a)
Belmont	Slow	60,000,000	45,200 (a)
Washington, D.C.	Slow	100,000,000	30,000 (b)
Cincinnati, Ohio	Rapid	112,000,000	11,400 (c)
Columbus, Ohio	Rapid	30,000,000	13,000 (d)
Dallas, Texas	Rapid	15,000,000	13,000
Harrisburg, Pa.	Rapid	16,000,000	10,300
Little Falls, N.J.	Rapid	32,000,000	15,000
Lorain, Ohio	Rapid	6,000,000	14,000
New Milford, N.J.	Rapid	24,000,000	11,000
Watertown, N.Y.	Rapid	8,000,000	11,250
Weighted averages	Slow	....	$32,600
	Rapid	....	12,100

(a) Cost of preliminary filters included.

(b) Cost of Dalecarlia Reservoir not included. Cost of McMillan Park Reservoir included, and also cost of remodeling Georgetown Reservoir, as well as cost of coagulating basin.

(c) Cost of large plain sedimentation basin not included.

(d) Cost of softening works not included.

The above figures show that the approximate relative cost of building the slow sand and rapid sand filter plants mentioned was $32,600 and $12,100 respectively, per million gallons daily capacity. At 5 per cent. the fixed charges on these sums would amount to $4.47 and $1.66, respectively, per million gallons of water filtered.

Operation and Maintenance.—The cost of operation and maintenance of filtration plants in a large measure, varies, of course, with the quality of the raw water. In a general way the following examples will serve to show the charges ordinarily made against the operation and maintenance of representative water filter plants in this country.

Cost of operation and maintenance of slow sand and rapid sand filtration plants.

Year.	City.	Kind of sand filters.		Average volume of water filtered daily.	Cost of operation and maintenance per million gallons of water filtered.
1911	Albany, N.Y.	Slow		20,000,000	$2.50
1912	Pittsburgh, Pa. ..	Slow		100,000,000	3.41
1911	Philadelphia, Pa. .	Slow	(a)	9,000,000	5.62
1911	Philadelphia, Pa. .	Slow	(b)	13,000,000	3.59
1911	Philadelphia, Pa. .	Slow	(c)	38,000,000	3.88
1911	Philadelphia, Pa. .	Slow	(d)	202,000,000	1.91
1912	Washington, D.C. .	Slow		62,000,000	4.01
1912	Cincinnati, Ohio	Rapid		50,000,000	4.12
1911	Harrisburg, Pa. .	Rapid		9,000,000	3.03
1912	Little Falls, N.J.	Rapid		30,000,000	3.20
1912	Louisville, Ky. ..	Rapid		25,000,000	3.48
1912	New Orleans, La. .	Rapid		16,000,000	6.32
	Weighted Average ..	Slow		....	$2.86
		Rapid		...	4.04

(a) Lower Roxborough; (b) Upper Roxborough; (c) Belmont; (d) Torresdale.

To summarize, the average cost of building seven of the largest and most modern slow sand filter plants was $32,600 per million gallons daily capacity; and, likewise, the average cost of building six of the largest, and two medium size, rapid sand filtration plants was $12,100 per million gallons daily capacity. The average cost of operation and maintenance varied widely, of course, but averaged $2.86 and $4.04 per million gallons of water filtered by the slow sand and rapid sand filters, respectively. Adding these last figures to the fixed charge on the first cost of construction makes up the following totals:—

Slow sand filtration ....$7.33 per million gallons
Rapid sand filtration ....$5.70 per million gallons

Relative Hygienic Efficiency of Slow Sand and Rapid Sand Filters.—In former years the slow sand process of water purification was favored by the majority of sanitarians and engineers because it was considered that, as compared with the rapid sand process, the former process was more nearly a "natural" one and hence less liable to failure. The actual results obtained from both systems have long since shown this assumption to be unfounded. Both processes require careful and intelligent management, but there is no room for doubt that if there is any choice between the two as regards hygienic efficiency it belongs to the rapid sand process. Well designed and built plants of this type not only can purify water of any character, turbid, colored or clear, so that the filtered product will always be clear and colorless, but are less liable to show sharp diminution in bacterial (hygienic) efficiency in cold winter months, or when the character of the raw water is seriously contaminated with certain industrial wastes. Chemical treatment is an integral part of all rapid sand filter processes, but is a makeshift when used in conjunction with slow sand filter processes; and the more complicated the chemical treatment prior to filtration the more likely are the final slow sand filters to fail.

In brief, wherever chemicals are or should be used in the preparation of water for filtration, it is proof that the slow sand filter is out of its element and in a field which, on grounds of economy at least, belongs exclusively to the rapid sand system.

In support of the assertion that rapid sand systems are at least the equal of slow sand systems with respect to hygienic efficiency, Mr. Johnson presents a table showing the typhoid fever death rate in certain American cities using slow sand or rapid sand filters. It is seen that the residual typhoid in those cities having rapid sand filters is 27 per cent. less than in those having slow sand filters.

Comparative Growth of Rapid and Slow Sand Filtration in the United States.—The growth of water filtration in the United States, particularly during the last dozen years or so, has been remarkable. In 1900 but 1,860,000 people were being supplied with filtered water, and in 1905 the United States was inferior to Japan in this regard. Since 1900 the population so supplied has increased by 830 per cent.

In the decade 1900-1910 slow sand filtration showed a remarkable increase with respect to the population supplied from such plants. This was largely due to the construction of the plants in Philadelphia, Pittsburgh and Washington, these three cities contributing over 2,000,000 of the increased population served by that system of filtration noted in the decade 1900-1910, namely 3,523,000. The increase during the same period in the number of people supplied with water from rapid sand filter plants was even more remarkable, totaling 5,422,000, or 54 per cent. greater than in the case of the slow sand filter systems.

"Since 1910 the slow sand filter has failed to maintain the rate of increase noted during the previous decade, the additional population served at this date, as compared with 1910, being 1,515,000. During the same period the additional population served by rapid sand filters was 4,971,000. The proof is plain, therefore, that the slow sand filter has about reached its limit, while the rapid sand filter is growing faster each succeeding year."

The paper contains tables and diagrams serving to show how the practice of water filtration has grown, and the respective parts which slow sand and rapid sand filter processes have played in the development of this important branch of municipal sanitation.

It is to be noted that of 40.68 per cent. of urban population supplied with filtered water 27.98 per cent. is supplied from rapid sand filters.

GOOD ROADS PREVENT DISEASE.

Few persons, on first thought, would see any possible connection between good roads and good health. Yet the State Boards of Health of Ohio and Kansas say that by the removal of weeds and trash good roads can and will prevent disease. Weeds and trash prevent the prompt evaporation of moisture and promote retention of ground water. This makes ideal breeding spots for mosquitoes, flies and other insects, which are known as disease carriers, not to mention chinch bugs, hoppers and other insects which are crop damagers. Furthermore, an undergrowth of weeds invites the dumping of garbage and manure by offering concealment, of which fact careless and thoughtless people are prone to take advantage, thus increasing the facility of insect breeding and providing these insect carriers with proper material for disease transmission.

Good roads also prevent disease by providing good drainage. Many farms have no means of drainage except by ditches along roadways. Open ditches, clear of brush and debris, with hardened surface and proper fall, afford these farms the opportunity of ridding themselves of many a stagnant pool. The removal of weeds, proper road grading, surface hardening and oiling, insures prompt drainage of all pool, ditch and surface water, removing the possibility of insect breeders, for none can multiply without moisture. Road oiling in itself is destructive of insect larvæ, especially mosquitoes—a well-known fact. Dry roads offer pedestrians, and notably children who are compelled to walk to and from school, dry shoes and feet. While colds are due to specific germs, yet it is a well-known fact that cold, wet feet and chilled limbs lower the resistance of individuals and make them more favorable subjects for infections of the respiratory passages, including pneumonia and tuberculosis. Good roads prevent disease by setting an example to adjoining farm premises. Good roads promote travel and set an example to the farmer whose premises are bordered by them. The comparison of a well-graded, clean highway with an unkempt and trashy barnyard adjoining is sufficient to stimulate every landowner to a clean-up. Pride compels him to offer to passers-by a neat-appearing and attractive house and barnyard. Results are only too obvious. Good roads are active disease prevention agencies, aside from their financial and commercial value.

THE GRADING AND DRAINAGE OF ROADS.

DETERMINATION of the amount of grading to be done in connection with the improvement of any highway depends upon the amount and nature of the travel and the topography. Excessive grades increase the cost of transportation and also add a heavy burden of maintenance, and it is always advantageous to lengthen a road and eliminate an excessive grade. This, as a whole, should be governed by the axioms enumerated by S. D. Foster, Chief Engineer, Pennsylvania State Highway Department, in his paper to the American Road Builders' Association in December last. These axioms may be stated as follows:—

1. No greater load can be moved over a highway than is moved over the maximum grade. 2. It is generally true that a road over a hill is equal in length to one around the base. 3. If the tendency of the topography is toward a continued elevation, the grade line should never be allowed to have a descending grade, and vice versa.

Sacrifice of straightness or of grade will be dedependent upon the predominant nature of the travel. Where horse-drawn vehicles predominate, alignment should give way to the lessening of the grade, as horse-drawn vehicles demand easy grade in preference to straight roads; where motor travel predominates, the grades should give way to alignment, for the rapidly increasing use of motor vehicles places a new responsibility upon the roadmaker—the reduction of danger to life and property, which necessitates building highways with long, easy curves.

Drainage.—In determining the amount of drainage it is well to remember that the ability of earth or soils to sustain loads depends largely upon the moisture present. Most soils can be compacted to form a good, firm foundation as long as they are kept dry, but when wet they become soft and in a great measure lose their sustaining power. The main problem, therefore, in the construction of a highway is drainage, which is dependent upon proper location. If the ground is level and not subject to flood there is seldom difficulty in location, but marshy ground underlaid with quicksands is expensive to deal with and generally should be avoided, even though it involves a considerable detour. A quicksand well drained often makes an excellent foundation for a road; the drainage, however, must be thorough and rapid. If the ground is level and subject to flood, mainly by backwater, an adequate number of small drains will usually accomplish the desired result, except that it may cost a good deal to raise the grade of the road above flood level. Cases sometimes arise where it is more economical to build a road floodproof at a lower level and submit to an occasional interruption of traffic than to make a wide detour or go to the great expense of a fill or viaduct.

Roads Subjected to Floods.—If the ground is level and subject to floods running at high velocity great care is necessary. The natural channel of the stream is altogether insufficient to carry the flood water, and, if the bridge crossing the stream is made large enough to permit the flow to pass under it, extensive erosion is liable to take place. If overflow bridges are built they are very likely to cause formation of side channels. Usually, the best treatment is to build the bridge large enough to pass the whole stream in flood time, straighten and widen the channel of the stream as much as possible, remove obstructions and protect the banks at exposed points.

In some cases it may be necessary to allow the flood water to overflow the road at some points, which must, of course, be made floodproof. Where such overflow points are provided, they should be made long and shallow to reduce as much as possible the velocity of the current flowing over them; otherwise adjacent property will suffer unnecessarily. These low places should also be so located as to reduce the actual damage to the minimum, as it is the duty of the public official to protect the just rights of all parties. If the proposed road crosses a narrow valley with a rapid stream, it is almost always best to give the bridge ample waterway and fix the grade above the reach of high water, taking care, of course, to protect all exposed points against erosion. Where valleys are to be crossed it is always better to cross them where they are narrow and the streams rapid. Such conditions reduce the amount of embankment required and also the span of the bridge, requiring more substantial construction, but proving more economical and more enduring.

One other condition met with frequently upon the highways of Pennsylvania is that arising from the tendency of one stratum of soil to slip upon another and thus cause landslides. These are most difficult and expensive to deal with, and it is seldom if ever worth while to attempt to hold such a movement of earth in place by piles or retaining walls. The only sure treatment is the thorough cutting off of the water before it enters the sliding mass. French drains with suitable laterals are generally better than tile drains, the usefulness of which may be destroyed by a slight movement in the slide. The drainage must be ample, as regards the sizes and lengths of the drains and the sufficiency of the outlets. This is sometimes a very expensive treatment, but if well done a permanent cure is generally effected.

The Ontario Government has secured an option upon timber rights in a large section of the limits of the Pembroke Lumber Company in and immediately adjoining the Algonquin National Park. The limit taken over, and by order-in-Council brought within the park, is chiefly valuable to the province from the fact that it contains a splendid stand of young pine. The price to be paid by the Government is $185,000.

Repairing a Locomotive with Portland Cement.—The Chesapeake and Ohio Railroad Company have successfully used Portland cement for the temporary repair of a fissure, 3-in. long, in the steam chest of a locomotive engine. Cement was employed because the part affected was inaccessible for the customary treatment. It is stated that after having been in service for eight months, the locomotive was sent to the shops for general overhauling, when the cement lining was found to be so perfect that it was left in place.

The conference of the International Waterways Commission just concluded at Washington, D.C., has resulted in the decision of the commission, first, to employ leading sanitary engineers to study the problem of the pollution of boundary waterways, then to give them a hearing, which will be in New York about the middle of May. After that hearings will be held in the various cities and towns affected, Buffalo and Detroit, as the two largest, being the first to be visited by the commission. The commission will meet again at Sault Ste. Marie on May 4th to investigate the water power project which American and Canadian concerns desire to build at the point, and which will affect the level of Lake Superior.

Sir Robert Perks, the English contractor, has received a contract from the Russian Government to build what will be practically a new harbor at Vladivostock. The port has deep water and other natural advantages, but so far little has been done for its improvement by the government of the Czar. Some time ago the Russian Government undertook to double-track the great Trans-Siberian Railway from the Pacific to St. Petersburg, and that work being now near completion, attention is turned to the proposed terminals which will cost millions of roubles. The contract which Sir Robert is soon to enter upon will comprise accommodation for both war vessels and merchant shipping and the contractor has several years to complete the work.

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CONTENTS OF THIS ISSUE.

FUNDS FOR HIGHER TECHNICAL EDUCATION.

The Royal Commission, appointed in 1910 to enquire into the needs and present equipment of the Dominion of Canada with respect to industrial training and technical education, has recently submitted a voluminous report in which many findings are presented and recommendations made. Its investigations into the systems of education in this and other countries have disclosed many shortcomings as well as some commendable features.

In the matter, for instance, of technical education of university or college grade, although a complete study of the organization of institutions and causes of instruction was not entered into, a study of the effects of the higher forms of technical education upon progress in industry and trade brought out one outstanding fact.

In France, Germany, Switzerland and the United States, the power and influence of technical education of the highest types appeared to be greater than in the United Kingdom or in Canada. In England, moreover, the opinion most frequently heard—and it was earnestly urged—was to the effect that hereafter the industries must somehow secure the services of more men of the highest scientific attainments with thorough technical training, or her manufacturers and merchants will not be able to hold their own against foreign competition.

The faculties of applied science of colleges and universities in Canada have the reputation of preparing engineers for professional work in a thorough and satisfactory manner. From what was learned abroad by the commission, the opinion appears to prevail that students in technical colleges, at some time before they graduate, should have obtained experience with materials, tools, machines and products for the purpose of giving them a clear understanding of principles and a correct knowledge of the conditions of production and construction which prevail in shops and factories. It is not important that they should have enough practice to develop either skill or speed as workmen in manipulative labor.

Technical education for the preparation of technical engineers, and other persons being trained for professional work of a grade and rank similar to theirs, would be improved, states the commission, by further extensions in the direction indicated by the practice in Germany, where industry and trade require, precisely like the German army, a number of intellectually highly trained officers, who are recruited almost exclusively from the technical colleges. These colleges educate the leaders of industry and also the state and municipal officials who are entrusted with the execution of technical problems.

The universities and colleges in Canada are providing technical courses to meet the demands from an increasing number of students. The rapid growth and development of the country, and the further application of science and scientific methods to all forms of production, construction, conservation and administration, will call for still larger numbers of graduates. In consequences the universities and colleges are sure to require increased financial support. The commission expresses itself to be of the opinion that this should be provided from some source without causing the fees required from students to be so high as to exclude suitable young persons who may seek the highest grade of technical instruction.

The report, as a whole, is well seasoned with admonitions that the higher educational centres of Canada are not yet at such a stage of excellence and proficiency that the country can sit back and entertain thoughts of retrenchment of financial support. The advice which the commission imparts in this respect is most timely, as the

severity of lack of funds is making itself keenly felt in some of our institutions upon which we are placing a great deal of dependence for a continuation of Canadian enterprise and awakening. When, after a world-wide survey of industrial and educational conditions, Canada is advised by its Royal Commission that an increase of financial support is necessary for the proper education which its national problems demand, there is only one thing to do.

CANADIAN ROAD CONGRESS.

Canada's first Good Roads Congress will be held in the "Arena" at Montreal, May 18th to 23rd, and it is expected that it will be attended by several hundred delegates from all parts of the Dominion, and by many from the United States, all of them enthusiastically interested in the international awakening to the necessity for the betterment of urban and interurban streets and highways.

Geo. A. McNamee, secretary of the Automobile Club of Canada, has been appointed secretary-treasurer of the congress, and has associated with him the following men: Former Alderman U. H. Dandurand, of Montreal, is chairman of the congress; H. W. Pillow, president of the Automobile Club of Canada, and Oliver Hezzlewood, president of the Canadian Automobile Federation, are among the active workers.

Hon. Chas. Tessier, Minister of Good Roads for the Province of Quebec, elected to this position during the last week in March, has given the congress his official sanction. Endorsations have been received from W. A. McLean, president of the American Road Builders' Association; W. J. Kerr, president of the Canadian Highways Association, of Vancouver, and F. R. Robinson, chairman of the Saskatchewan Highway Commission, of Regina.

The congress will be opened at 3 p.m., May 18th, by the Honorable Lieutenant-Governor of the Province of Quebec, Sir Francois Langelier, assisted by Sir John M. Gibson, the Lieutenant-Governor of the Province of Ontario. Official representatives will be present from the French, British, United States and Canadian governments, and addresses will be given by more than two score men of prominence.

Over $60,000,000 is available in appropriations in Canada for expenditure for good roads during the current year. The congress delegates will debate, as one of their most important problems, the best and wisest method for outlaying this huge sum. Thirty-three millions is the amount which will be spent under provincial supervision, and the other twenty-seven millions will be spent by cities, towns and townships. This estimate, made by Geo. A. McNamee a few weeks ago, is said to be a conservative one, and has since been augmented by Ontario's appropriation.

EDITORIAL COMMENT.

Work on the Welland Canal has made remarkable progress during the past month. Sections I., II., and III. are being operated upon while Section IV.-A will be commenced immediately. This sub-section was awarded last week to Maguire and Cameron, St. Catharines, Ont. It comprises the construction of a diversion weir and of culverts at several points between the present and the old canal, after which a portion of the old canal will be filled in and the space between it and the present canal used as a dumping ground.

THE ENGINEER AND THE PUBLIC.

THE following remarks are extracted from several recent addresses of Walter J. Francis, C.E., of Montreal—one to the Ottawa branch and another to the Calgary branch of the Canadian Society of Civil Engineers, on the 2nd and 9th inst., respectively:—

It is, perhaps, easier to say what an engineer is not than to say what he is. The expression engineer is most difficult to define. Turning to a dictionary it will be found that an engineer is one who practises engineering, or that he is one who schemes or contrives. One of the most eminent jurists of the United States struggled with this problem for twenty minutes—to come to the conclusion that the engineer is a good fellow. To define engineering is about as difficult as to define engineer. It may be presumed that the logical dictionary method would be to say that engineering is the art practised by an engineer. The Institution of Civil Engineers of Great Britain refers to "the art of directing the great sources of power in nature for the use and convenience of man." The Canadian Society of Civil Engineers refers to "the profession of a civil engineer whereby the great sources of power in nature are converted, adapted and applied for the use and convenience of man." Is it any wonder that the public does not understand what we are when we have so much difficulty resulting in trying to say what we are. It would appear that Professor Swain has devised a definition which is, at least, comprehensive. He calls engineering the application of the laws of nature, the principles of mechanics and the materials of construction, to the business of the world.

The classes of engineers were placed by Mr. Dunn, the President of the American Institute of Electrical Engineers, in Boston a couple of years ago, as numbering 27. Later, some individual of a statistical turn of mind isolated 110 distinct species of engineer. Since then four others have been discovered, which gives a factor of safety of two as compared with the famous "57 Varieties."

Much of our difficulty doubtless arises from the peculiar combination of the two words, civil and engineer, which occurred long before the present state of engineering art, at a time when it seemed desirable to separate those who were engaged by the Government in purely military works from the presumably less important number who made their living without attaching themselves to the Ship of State. This word civil has been a great source of haziness for a long time. Doubtless it will disappear in the not-distant future. The great engineering organization already recognizes distinctions even amongst the military engineers.

The word engineer is very much abused. There has been noted with much pleasure the persistent care with which one of the vice-Presidents of the Society always refers to his numerous locomotive drivers as engine-runners or enginemen, either of which terms is very definite and easily comprehended. It is a fortunate thing that the man who drives a street car is satisfied to style himself a motorman, that the driver of an automobile prefers to be known as a chauffeur, and that the aviator does not wish to be called an aeroplane engineer. If the man who runs an engine must be called an engineer, what would you call a man who runs a wheelbarrow?

One of the safest standards for judging what an engineer should be may be taken from the requirements of the highest grade of membership in the three great engineering Societies of English-speaking engineers, the Institution of Civil Engineers of Great Britain, the American Society of Civil Engineers and the Canadian Society of Civil Engineers. All of these recog

nize four principal qualifications, namely, age, education, occupation and professional experience. For full membership the Institution requires one to be at least 33 years of age, the other two have a minimum age limit of 30. All three require a liberal education, while the Institution and the Canadian Society of Civil Engineers consider university graduation a great benefit and the equivalent of several years' experience. Regarding occupation, the requirement is that the candidate must be in active practice and have been engaged in engineering work for 10, 12 or 15 years. The professional experience demanded is ability to design and direct engineering works and having had at least five years of responsible charge of important work, the Institution requiring also that the candidate shall have attained a considerable degree of eminence in the profession. Comment on these requirements would seem to be superfluous. It is practically impossible for a person to attain the requisite experience before reaching the age of 30. Education never made an engineer, but it has made many a good foundation. Occupation and professional experience are essential features. All of the Societies make provisions for young men to enter their ranks and to have advantages while climbing upwards to the highest grade.

Is the Engineer a Professional Man?—The question naturally arises, "What is a professional man?" and we instinctively think of the lawyers, the doctors and the clergymen.

One of the distinguishing features of their profession is a representative governing body. The distinguishing feature of each professional body is its code of ethics. The distinguishing feature of professional men is that their remuneration is independent of the result of their labors. A professional man would then seem to be one who is engaged in mental labor, associated with a recognized governing body directed by a code of ethics and receiving recompense without reference to profits resulting from his work. Judged by this standard alone, the engineer as a whole cannot be classed as a professional man, because many of our greatest engineers are engaged in some form of business, such as contracting, bridge-building, shipbuilding or manufacturing, whereby their remuneration depends on the success or failure of undertakings. In medicine, for instance, if a doctor were to exploit one of his prescriptions for the sake of deriving profit therefrom, he would no longer be considered a member of the profession, notwithstanding the fact that he may still have the same high moral character, the same medical skill and the same interest in the alleviation of suffering. Because he is deriving a profit from the sale of his medicine he is considered to be in business.

It will be interesting to digress for a moment in passing to refer to the positions that the three professions, law, medicine and theology, have attained in the mind of the public. They have, of course, all been at it for centuries. The Inns of Court go back so far that it is difficult to arrive at the true history of the organizations of legal men. The doctors co-operated so long ago that the commencement of their organization seems to be lost track of. The preachers have had very close corporations from the beginning of history. These three professions are examples of the strongest possible kind of close corporation. It is impossible for a man to practice in any one of them without the full consent of the governing body. Indeed, to attempt to practice in some of these fields would be to commit an offence against the law of the land. The strength of the professions of law and medicine in this sense is due in a great measure to two important factors, one, the education of the young men entering the profession, and the other the part played by the older members of the profession as representatives in Parliament. As an example of the influence of the medical profession on the education of the coming generations of doctors, two years ago the Carnegie Foundation sent out too representatives, who paid a visit to, and studied the course given in, all the medical colleges of America. These representatives reported to the Foundation. Since that time 39 medical colleges have closed their doors and every other medical curriculum has been altered.

In theology the lines of denominations are so firmly fixed that the most absolute of all close corporations exist, corporations that have practically absolute control of the most far-reaching of all civil contracts, namely, the marriage contracts. These points are mentioned merely to show the result of the efforts of time and organization.

The position attained by the older professions cannot be attained by engineers in a short time. Law, medicine and theology are as old as the hills. Engineering is a modern art. By the very definition of Professor Swain it will be seen that it was impossible for man to have an art of engineering until he understood the laws of nature and the principles of mechanics. What he knows of these things he has not known long, and probably he knows them still imperfectly.

The above-mentioned engineering societies must be considered as technical societies and not professional societies. The statement that there is only one professional society of civil engineers in America may sound rather novel and improper to many. About three years ago there was formed in New York City the organization known as the American Institute of Consulting Engineers. Since that time similar bodies have been instituted on the Continent, and quite recently in England. The distinguishing characteristics are that the minimum age for admission is 35 years, and that a candidate for membership must be of good personal character and high professional reputation. The qualifications required are higher than those of any of the other engineering socities, and it is expressly forbidden for any member to engage in contracting.

This organization has a very rigid code of ethics, as well as a schedule of fees.

The Relation of Engineers to Each Other.—The code of ethics of the Canadian Society of Civil Engineers may be taken as a reasonable guide for conduct towards a fellow-engineer. It does not require anything more than the respect accorded by doctors to other doctors or lawyers to other lawyers.

The Relation of the Engineer to the Public.—The public seems too prone to consider the engineer a sort of glorified plumber, and we immediately come to the anomalous situation that that same public, while hesitating to attempt to wipe a joint on a lead pipe, would rush in and express the most decisive opinions on larger questions, believing that they know all about the laws of nature and the principles of mechanics.

The daily press is not blameless in its comparative appreciation of engineers. It is frequently observed that four lines or so are given to the reference of some important engineering gathering, while a whole column of the same issue is devoted to a popular story about "a veteran engineer." One reads the column only to find that it refers to the man who operates the throttle-valve on the engine of a river-boat. Such a man is not by any means immune from praise and noteworthiness. It is evident, however, that there is a lack of distinction between those persons represented by the creators of the engine and those represented by a man who operates it.

It is the common public practice for corporations, municipalities, and even individuals, to invite competitive bids for engineering services. Permit an analogy to be made with medical men. Suppose a person were afflicted with a tumor. Then let him send out invitations, far and wide, to surgeons to ascertain their prices, when they can do the work, complete specifications for the operation, and the photograph of the applicant. Having chosen the two lowest bidders, one of whom happens to be the handsomest of the bunch, perhaps, the tumerous individual proceeds to work the two competitors against each other, with the result that the homelier-looking one underbids the pretty one by $3.60 and gets the job.

Then, the native engineers are very apt to be forgotten by the press. Not long ago one of the foremost newspapers of Canada had an article stating that as American engineers had failed in a certain Canadian proposition it had been necessary to call English engineers.

One is apt to think at times that the unfortunate failures in engineering are unduly advertised. For each one failure, there are thousands of successes in engineering. In this regard the engineer as compared with the lawyer, the preacher and the doctor is severely handicapped. In the case of the lawyers on opposite sides in a suit, one of them must necessarily lose. The preachers deal in futures, and nobody has as yet been known to return to tell us about their mistakes. The doctor buries his.

It cannot be denied that the engineer has not yet reached in public and parliamentary life the eminence of the doctor and the lawyer. Give him time, wait until he gets a little older, and it will be found that the engineer will be just as successful in the legislative halls of the country as he has been in the great outside world.

The fact that the remuneration of engineers is steadily increasing shows in a tangible way that the appreciation of the public is growing.

What the Engineer is to Expect of the Public.—The engineer has a right to expect from the public the same consideration as accorded to doctors and lawyers.

The engineer should frown upon competitive prices for engineering services. The stand recently taken by the Institution of Civil Engineers in a letter written last month is a very firm one. It is as follows:—

"The Council have had their attention drawn for some time past to a practice which exists among local authorities, of inviting by advertisement engineers to submit in competition with others their terms for preparing plans and proposals for certain engineering schemes, accompanied then or perhaps at a later stage by estimates of the cost of the works proposed.

"In the opinion of the Council such a proceeding is very undesirable in the best interests of the public authorities themselves and is derogatory to the engineering profession. The Council desire to express emphatically that repugnance with which they regard the practice in question. They have every confidence that the members of the Institution will support them by declining to respond in any way to such advertisements as those alluded to.

"The Council have informed the Local Government Board of their action in making this communication to the Institution."

The engineer has a right to expect the medical and the other professions to refrain from entering the field of the engineer. I doubt if an engineer ever lived who would have the temerity to suggest the course whereby a surgeon should accomplish a certain result.

The engineer has a right to expect his country to prefer him before the engineers of other countries. Where unusual skill or highly specialized advice is necessary, it matters not where it be obtained, but having obtained the advice if necessary, the native engineer should be in a better position to deal with the problem as a whole than the men from outside. Canadian engineers can do the engineering of Canada. The work of Canadian engineers stands before the world as a monument to the ability and integrity of Canadian engineers.

How is the Engineer to Reach the Public?—The question of publicity by an engineer is a somewhat delicate one. Proper and improper methods of soliciting work have recently been the subject of carefully studied discussion, and the consensus of opinion seems to be that dignified and proper publicity by such means as professional cards and the way in which doctors and lawyers obtain their practice is the best course. It is generally conceded that a competent and dignified engineer will not solicit work. He does not need to.

The best way of all to reach the public is by education along broad lines in showing the public what the engineer has done. Too many of us are nothing more than animated slide-rules. Too many of us are narrow-minded. Too many of us think we are so busy that we have no time to take the interest of the true citizen in public affairs. Remember that in life there is more than dollars. Next to the agriculturist, the engineer is the greatest producer in the world. The transportation problems and the questions of communication are all in the domain of the engineer. It is for the engineer to design the conveyance for use on land, on and under water and in the air. The influence of the engineer on the arts and sciences should also be spread abroad. The greatest advance in architecture since the ancient orders was the introduction of steel skeletons and reinforced concrete by the engineer. The great advances in surgery result from the engineers' inventions in instruments, as well as electrical and other devices.

How is the Profession to be Elevated?—The profession is to be elevated by the thorough education of the young man entering it, such education being followed by careful training and long, hard experience.

The profession is to be elevated by the dignity of every engineer and by the perfection of his work.

The profession is to be elevated by co-operation with fellow-engineers and by association with the Canadian Society of Civil Engineers.

GARBAGE INCINERATION.

Incineration is the most efficient, sanitary, and, if properly managed, economical way of disposing of garbage in cities and large towns. Mere dumping in a huge midden is not disposal in the true sense of the word. It is simply an attempt to segregate a nuisance. Burial of rubbish requires a large area of ground and a long haul. It may be suitable for small towns that cannot afford an incineration plant, but it is out of the question for larger centres. Dumping into water should never be permitted except by cities on the seacoast, and only then provided the tides are favorable and the waste material will not be washed back on the shore. Reduction of garbage in "digesters" to remove grease is practised in many United States cities, but the capital required and the operating expenses are high. Moreover, such reduction plants are liable to give rise to foul odors, and many kinds of rubbish, such as bottles, tin cans, broken furniture, cast-off clothing, etc., cannot be disposed of in this manner.

THE TRANSPORTATION PROBLEM IN CANADA, AND MONTREAL HARBOR.

THE following abstracts are from a paper read on April 7th, 1914, at a meeting of the Institution of Civil Engineers of Great Britain. The speaker was Fred. W. Cowie, B.A.Sc., M.Inst.C.E.

The population of the Dominion of Canada is about 8,000,000, and the foreign trade per capita is $125.

The population of Montreal, including the connecting municipalities, is about 600,000, and the foreign trade of Montreal per inhabitant is over $600. As a comparison, England (United Kingdom) has a foreign trade per capita of $125, Germany $67, and the United States $41.

The total land area of Canada is 3,600,000 square miles, so that the density of population is less than two per square mile, as compared, for instance, with thirty-one per square mile in the United States.

It has been stated by trade experts that the difference between the average price received by the producer of Western Canada and the price paid by the consumer of the food products is 33 per cent. For wheat for which the consumer pays $1 the farmer therefore receives 67 cents; 33 cents are paid for transportation and handling, and to the selling organizations. It is equally vital, therefore, to the producers in Western Canada and to the consumers in Great Britain, that this latter percentage should be reduced to the lowest possible figure, so that the farmer may receive the full due for his toil, and the cost of living in Great Britain may not be unduly enhanced.

Another consideration which is of vital interest to Canada is the absolute necessity of collecting by her own people the transportation and selling tolls.

As an illustration, it may be stated that, although in Montreal harbor 60,000,000 bushels of grain were handled in 1913, nearly 100,000,000 bushels of Canadian grain were shipped in the same year through Buffalo in the United States.

The cost of transportation per bushel, from the average point of divergence to the United Kingdom, may be stated, for the various stages, as approximately 18 cents.

For every bushel of grain shipped through Buffalo there is therefore a loss to Canadian transportation and selling organizations of about 18 cents, or for 100,000,000 bushels $18,000,000.

Transportation in Canada.—Even with these striking illustrations it is not easy to fully appreciate what is known in Canada as the "problem of transportation." A comprehensive view of the Dominion and the North Atlantic to Europe is shown in the paper by an original map drawn to scale (Mercator's Projection), showing Canada and the northern half of the United States, with the trade routes to Europe. The main routes are naturally "east and west," and the vast area tributary to the River St. Lawrence is geographically shown.

The "north and south" routes through the United States are principally by rail or by the Erie Canal from Buffalo to American Atlantic ports. The Erie Canal was created by the United States to offset the advantages of the St. Lawrence route. The magnificent railway systems between New York and Buffalo are the most powerful rivals of the "all Canadian" routes.

The opening-up of the vast productive areas of Western Canada, where it has been found that with one-tenth of the cultivable land under crop, 200,000,000 bushels of wheat, and double that quantity of other grains, may be grown, has established, within the last few years, entirely new transportation conditions.

With the tremendous tide of emigration from both Europe and the United States to the new provinces, this production will necessarily increase greatly, and the "problem" is, how to provide the required transportation facilities.

A table of transportation routes from the Canadian West to the United Kingdom is given. This interesting table is worthy of study, as not only present routes are shown but important projected and commenced lines of trade are indicated.

Great efforts are being put forth by the Canadian government and the transportation and other corporations to improve facilities, so as to cheapen and render available Canadian routes; but at the same time similar and extraordinary efforts are being made to improve Buffalo harbor, the Erie Canal, the rail routes, and the harbors of Boston and New York.

In the opinion of the author, who advances striking illustrations and argument, with equal effort, the advantages for future transportation should lie with the St. Lawrence route.

Montreal's Position on the Line of Route.—From the West to Montreal.—The transportation routes in Canada almost all lead to Montreal.

Up to the present the only real rival to the Montreal-St. Lawrence route is the United States route via Buffalo and New York. The western trunk lines of the United States have been improving their "north and south" connections so as to tap the three great western provinces of Canada. These railways provide excellent services to Duluth and Chicago.

A further diversion is made to the United States route at Port Arthur and Fort William. From this twin port at the head of the Great Lakes, the cheapest commercial navigation in the world enables grain and other products to be shipped to Buffalo. Between Buffalo and New York there are several splendid railway systems and the Erie Canal. The new Erie Canal, a modern barge-canal through the state of New York, giving a draught of 12 feet, will soon be completed at a cost, including harbors and damages, which is expected to reach $150,000,000.

The New York and Boston port authorities are at the same time making every effort to improve their harbors, and to provide such attractive facilities as will capture at least a large share of this growing Canadian trade.

By the Canadian routes everything goes by rail direct from the west to Port Arthur. From the twin cities, Port Arthur and Fort William, there are, with modifications, two distinct routes, namely, the "All-Water" route, direct to Montreal, and the "Lake and Rail" route, through Georgian Bay to Montreal.

By the "All-Water" route to Montreal, a distance of about 1,400 miles, vessels are limited by the present Welland and St. Lawrence canals to a draught of 14 feet, or 2,500 tons. An excellent type of vessel has been developed for this service, and the trip from Montreal to Port Arthur and back is made in 14 days.

By the "Lake and Rail" route vessels of 10,000 tons ply between Port Arthur and ports on the Georgian Bay. The Canadian railway companies have established magnificent elevators at Port Arthur and Fort William, and also at several Georgian Bay ports, so that loading and discharging may be carried on with unsurpassed facilities. From the Georgian Bay ports splendid railways are being built to Montreal and existing lines are being improved.

Montreal.—At Montreal harbor the St. Lawrence Canal system and all the great Canadian transcontinental lines centralize. The great Canadian railways—the Canadian Pacific, the Grand Trunk, the Grand Trunk Pacific and the Canadian Northern—are all feverishly improving their terminals at Port Arthur and Fort William, at Georgian Bay ports, and at Montreal.

The Canadian government has commenced the construction of the new Welland Ship-Canal between Lakes Ontario and Erie. This canal, with 800-foot locks and with a possible ultimate draught of 30 to 35 feet, will accommodate the large lake carriers so as to continue to Kingston or Prescott without breaking bulk. This will add greatly to the shipping in Montreal, and will, it is confidently expected, hold the greater part of the Canadian trade to the St. Lawrence route.

Montreal, however, under existing conditions of traffic and accommodation, is almost at the limit of its capacity. With double the present traffic assured within the next few years, it will require a great deal more and better harbor accommodation to meet the demands upon it.

Montreal to the Sea.—With the possible exception of the development of Glasgow there is no more romantic episode in the annals of harbor engineering than the making of Montreal an ocean port. Largely by the faith and energy of Scotch Canadians, following the successful improvements on the Clyde, the River St. Lawrence between Montreal and the sea has been deepened from less than 10 feet to its present depth of 30 feet at the low stages of the river level. During the early summer months the depth is greater, and reaches as much as 38 feet. The minimum width is 450 feet.

Although the author is not now connected with the staff of the River St. Lawrence Ship-Channel, he was continuously engaged upon that great work for twenty-two years, commencing as an assistant and being in charge as superintending engineer for ten years up to 1909. For many years this work has been looked upon as being one of the great successful public works of Canada, and under the Hon. J. D. Hazen, Minister of Marine, the work is now in charge of Mr. V. W. Forneret, B.A.Sc., superintending engineer, who for many years was the author's chief assistant.

The work is all carried on departmentally. The plant is owned by the government, and for its own special work is probably the most complete dredging plant and excavating machinery for submarine rock which is in existence at the present time.

At the present time, with magnificent range lights for each course, with a splendid system of gas buoys and a telephone signal service, navigation is considered very easy and safe by night as well as by day.

The deepening of the channel from 30 to 35 feet at extreme low water was commenced two years ago, and about one-fifth of the work to tidal water is already completed.

The natural fall in the river level between Montreal and Quebec, a distance of 160 English miles, is 29 feet. The maximum discharge of the river during the season of navigation is about 600,000 cubic feet per second, while at the lowest stages of water the minimum is slightly less than 200,000 cubic feet per second.

With the present average slope and velocity of current and average cross-section, the low-water river level and discharge are balanced, with an average current of about 3 miles per hour. This being theoretically correct, it may be considered assured, that if the water supply of the St. Lawrence remains unchanged and the natural cross-section of the river is not enlarged, the present river levels will be constant.

The permanence of the ship-channel and the St. Lawrence route would therefore appear to be well assured.

From Montreal via the St. Lawrence to the open sea the distance is nearly 1,000 miles, and, besides the attraction to passengers of 3 days' sailing in smooth water with beautiful scenery, the strong commercial consideration for water freights into the interior is the incentive to keep pace with increasing trade on the North Atlantic. During the season of seven months the commerce passing through Montreal is nearly 40 per cent. of the total commerce of Canada, and this percentage is increasing.

In 30 years only two ships have been totally lost between Quebec and Montreal, and the occasional groundings, which are well advertised, are not frequent. None of the accidents whatever in recent years has been due in any measure to the ship-channel.

Montreal Harbor.—The First Improvements.—In 1830 the first Harbor Commission was appointed under the authority of the Governor of the Province of Canada, for the purpose of carrying into effect "An Act to provide for the improvement and enlargement of the harbor of Montreal."

In their first annual report the commissioners recorded that they confidently anticipated that the wharves undertaken would be, when completed, superior to any works of the kind in the province, and would enable the City of Montreal to be advantageously contrasted with any other in North America for beauty, solidity, and convenience of approach by water.

This was the first attempt made to improve the harbor of Montreal by a commission. The commissioners had the same faith in the future of the harbor, and courage in undertaking works, which has characterized the administration from 1830 to the present time. The present harbor of Montreal justifies the modest boast of the commissioners of 80 years ago.

Scheme of Harbor Extensions of 1910.—In 1910, the author prepared for the harbor commissioners a comprehensive scheme of improvements, according to which it was proposed to develop the valuable water front and shores of the river, owned exclusively by the Dominion government and held in trust by the harbor commissioners, so as to result in the following revenue-producing features: (*a*) Sites for industries, by making land and improving connections with inaccessible properties; (*b*) the extension, enlargement and improvement of railway termini, giving equal facilities to all Canadian lines for connecting with harbor and industrial points; (*c*) facilities for encouraging and developing industries along the valuable water front.

According to the Board of Consultive Engineers, the items approved were estimated to cost $17,000,000, and this work is now in progress.

This winter condition is a surprise to those who are accustomed to ports open all the year round, but as the Great Lakes and their navigation, amounting to 75,000,000 tons annually, and their great ports are also all closed at the same time, and by the same cause, Montreal harbor does not suffer unduly. The shipping of the St. Lawrence in the autumn is at once transferred to the excellent Canadian ports of Halifax and St. John, and commerce is carried on all the winter as usual with only the disadvantage of the extra rail haulage.

A very full description is given of the physical features of the River St. Lawrence and Montreal harbor.

Construction conditions and types of construction are described and illustrated. They show that although the cost of labor is very high in Canada, this is counterbalanced to a large extent by the use of machinery.

The original "make shifts" for harbor construction are now being followed by modern design. The use of timber and concrete, and the designs to overcome the danger and damage from frost action, are described fully.

Floating Dock, Shipbuilding and Repairing Yard.—For many years the harbor commissioners of Montreal, urged on by the shipping and business interests, have endeavored at various times to solve the problem of the establishment of a dry dock in Montreal harbor.

Negotiations in 1909 with a shipbuilding firm and the final incorporation of The Canadian Vickers, Limited, solved the problem. The harbor commissioners agreed to furnish the site, situated on harbor property, in such a position that nothing would be done to hamper future extension of the harbor. The commissioners undertook to dredge the deep basin and to furnish a site of 30 acres of made land. The rental from the land and the increase in harbor traffic is expected to pay the harbor commissioners the interest on the outlay.

As a result, Montreal harbor has now a floating dock capable of docking the largest vessel trading to the St. Lawrence, at practically no burden on the harbor finances, and there are being established naval construction works capable, in a year or two, of building, in Canada, any vessel from a Dreadnought to a full-sized merchant ship.

This dock was constructed complete at Barrow-in-Furness, and towed across the Atlantic by two powerful tugs, reaching Montreal on 18th November, 1912. The length of the dock over platform is 600 feet, the width over all 135 feet, and the lifting capacity 25,000 tons. On the 18th November, 1912, H.R.H. the Duke of Connaught, Governor-General of Canada, formerly dedicated the new floating dock to the service of commerce and shipping.

The Storage and Handling of Grain.—As grain shipments in Montreal harbor constitute about one-fifth of the total annual freight handled, and as every effort is being made to meet competition so that the greater part of the Canadian grain exported shall be shipped through Canadian ports, special attention is given in this paper to the facilities for the storage and handling of grain.

It is acknowledged that the Montreal equipment is the latest and most successful, as compared with the facilities for the storage and handling of grain at any of the great ocean ports of the world.

As the most characteristic unit of this plant has just been completed, the author, who has had to do not only with designing but also with operating, gives a detailed description of the grain-handling trade, as well as of the design and construction of the plant in Montreal harbor. There is probably no lesson in port-management to be learned that will better illustrate how failure may be turned into success by arranging varied operations under one management and yet so centralized as to cover every requirement of a special trade without disturbing other departments of port business.

Elevator No. 1 was constructed in 1904. It was of the latest design and was placed in the most valuable site on the harbor. It could receive grain by railway wagons or by lake vessels at the rate of 16,000 bushels (400 tons) per hour. Ocean steamships, by moving to the elevator berth, could be loaded at double that rate.

The ocean vessels, however, declined to move to the grain berth to receive grain. It involved tug service, pilotage, etc., and interrupted other operations of loading and unloading, and they desired to ship grain at certain and convenient periods of unloading and loading. Tramp vessels were satisfied, but the proportion of tramps was small. In 1907 the working of this elevator devolved upon the author. The capital cost then amounted to about $1,000,000, the interest account to over $25,000, the operating and maintenance charges to an equal sum. The total revenue for 1907 was about $8,000, and the loss was over $40,000.

The system can store 3,600,000 bushels of grain, can receive about 800,000 bushels (20,000 tons) per day, and can deliver an equal quantity to any of fifteen ocean steamships at their regular berths, and to nine vessels at one time. With it, and with a fleet of six floating elevators for direct transfer, the harbor commissioners received, stored and delivered in 1913 nearly 44,000,000 bushels. The capital expenditure had now reached $4,500,000, but during this season, the first covering the operation of the complete installation, the system paid interest, maintenance, operation and depreciation.

This very complete and costly installation is the result of competition. Its purpose is to keep the trade in Canadian channels, and reduce the cost of transportation. While the Canadian Government and the harbor commissioners of Montreal are encouraging and cheapening transportation, there are those who, rightly or wrongly, are of opinion that improvements for the storage and handling of grain in the ports of the United Kingdom are not advancing in equal measure, so as to result in lower cost to the consumer and better encouragement to the producer. The importation of grain is one of the largest items of the shipping at several of the ports of the United Kingdom. The facilities for the economical handling of grain, and the cheap forwarding of it to the manufacturing mills are, however, far behind the modern successful American and Canadian practice, and even of the growing competitive North Sea ports. There is also a decided lack of such storage facilities as would guarantee food supply, and at the same time regulate shipments and, consequently, prices. In several of the magnificent new dock schemes, where such methods could be installed to apparent advantage, these features, which have been so successful in reducing costs in Canada, are apparently overlooked, although it is felt that, for so extensive a trade, they should receive exceptional attention. Otherwise further encouragement will be given to the United States millers to manufacture Canadian wheat, and ship the flour in convenient packages direct to the bakers, resulting in loss not only to Canadian transportation systems but also to British manufacturers, and further curtailment of the home food supply, to which public attention has been drawn.

The questions of storage and ventilation, and also the cost of modern elevators are dealt with, and the remarkable reduction in insurance rates in modern elevators is referred to.

The floating pneumatic elevator, discharging on to conveyer-belts in culverts leading to a central storage elevator, should be practicable at most of the new British docks. Construction work, labor, machinery, and power being cheaper than in Canada, the tariff charges, allowing for profit, should not be higher than in Montreal for a similar operation. The cost of insurance on grain in modern elevators is exceedingly low; the rate on grain in the Montreal harbors elevators is 20 cents per annum per $100, as compared with $3.20 per $100 in wooden elevators. With such storage facilities owners could store

in large quantities and hold for favorable markets, and the economic results on even a portion of the total imports into the United Kingdom, amounting to about 500,000,000 bushels per annum, would pay in a year for probably one such installation.

Cost of Elevators.—The cost of modern elevators has ranged from 40 cents to $1 per bushel of capacity, so that a million-bushel house costs from $400,000 to $1,000,000. The harbor commissioners' system, with a storage capacity of 5,000,000 bushels, and with its extensive conveyer system providing galleries to nineteen berths, will cost about $5,000,000, or $1 per bushel. Elevators of similar type and working capacity can be built without the conveyer facilities for about 60 to 70 cents per bushel.

A detailed description of the construction of the latest elevator is given in an appendix.

Of importance to engineers and architects and builders is a section of the paper on Vibration Tests of Reinforced Concrete.

Considering the experiments as a whole, it would appear that the effect of the vibration was to increase the tensile and crushing strengths of the concrete, rather than to reduce them. This is probably due to the fact that the vibration had the effect of compacting the concrete, filling the voids more completely, and driving out any air bubbles.

General Organization.—The banks and river-bed making up the area included in the limits of Montreal harbor are owned by the Federal Government of Canada, represented by the Minister of the Department of Marine and Fisheries. Within the limits of the harbor is included the two banks and the bed of the River St. Lawrence for a distance of about 17 miles. The area of land, improved and unimproved, is approximately 350 acres.

By statute the administration and control of this property are entrusted to the harbor commissioners of Montreal, a corporate body having exclusive powers by Act of Parliament for the improvement and management of the harbor, subject to approval by Order-in-Council. Except for police and fire jurisdiction the harbor is quite separate from and independent of the city. The commissioners build and maintain all roads on their territory, do the electric lighting, and have absolute control of traffic.

From absolutely unimproved shores in 1830, the harbor has been developed until now the value of the land, without including the extensive improvements, is much in excess of the bonded debt of about $20,000,000.

The present harbor commissioners are: Mr. W. G. Ross, president; Mr. Farquhar Robertson and Lieut.-Col. A. E. Labelle; Mr. David Seath is the secretary.

Ocean Tonnage.—The number of sea-going vessels which arrived during 1913 was 820, with a total net tonnage of 4,690,535 tons. An equal number of vessels with the same net tonnage departed.

COPPER BEARING STEEL SHEETS.

B. and S. H. Thompson and Co., Limited, Montreal, announce that they are prepared to supply samples and descriptive booklets of Keystone copper-bearing steel sheets. These sheets were placed on the Canadian market last year, and it is claimed by their makers that they have greater [illegible] than ordinary steel sheets and that they are therefore particularly adapted for use in the manufacture of all exposed sheet metal work.

A NEW PATENTED GARBAGE CAR.

As cities increase in size, the disposal of garbage becomes of more and more importance and in connection with garbage disposal, the following points must be considered.

(1) The garbage disposal plant must be located so that it will not be a nuisance to surrounding property. This means that it will often be located some distance from the centre of the city, and too far out to haul the garbage to the plant by horse and wagon.

(2) The receptacles in which it is conveyed must be water-tight to avoid leakage of the material and consequent nuisance on account of the odor.

(3) The receptacles must be constructed so that they can discharge their contents with minimum labor and cost.

For cities located on the sea-coast, the material is generally loaded into barges from the garbage wagons; but for the interior city, this method is not possible, and the garbage disposal plants are usually located some distance out from the city and on a railroad.

A switch is then obtained as near the centre of the city as possible, and the garbage wagons go to this point and dump their loads in large capacity cars which are hauled to the garbage destruction plant. The type of car which has proven most satisfactory for this purpose is shown in the cut. It consists of a large tank with semi-circular bottom and capacity of 1,200 to 1,800 cu. ft. The tank rests on rockers at the ends and at intermediate points on rollers so that it can be dumped and righted with the expenditure of very little power. These cars are built to conform to standard M.C.B. requirements in every respect, and are accepted for transit on their own wheels by any railroad. Large quantities of these cars have been supplied to Cleveland, Columbus, Toledo, St. Louis, and a number of other cities by the Orenstein-Arthur Koppel Company, of Koppel, Pa., who control and have patented the design.

DISCUSSION OF TRANSIT FACILITIES.

An interesting topic and one of great economic importance at the forthcoming International Conference on City Planning, in Toronto, will be the improvement of rapid transit facilities in our growing cities. A paper on "Provision for Future Rapid Transit: Subway, Elevated or Open Cut and their Influence on the City Plan" will be delivered by J. V. Davies, Consulting Engineer, Brooklyn Rapid Transit Company, and will be followed by another paper on "Rapid Transit and the Auto Bus," by John A. McCollum, Assistant Engineer, Board of Estimate and Apportionment, New York City.

An estimate of the water extensions necessary for this season at Fredericton shows a total cost of work that will be about $8,000; while the estimate furnished on sewer extensions approximates a cost of $10,420.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

CONTENTS.

BOOK REVIEWS.

Gear Cutting in Theory and Practice.—By Jas. G. Horner, A.M.I.Mech.E., published by Emmott & Co., Limited, Manchester and London, as one of their "Mechanical World Series;" 391 x xii. pp.; 367 illustrations; size 6 x 9 in.; cloth; price $2 net.

This is a very useful book for the mechanical engineer and shop man. It is practically devoid of technical formulae, the author endeavoring to incorporate the later developments of the art in a reasonably comprehensive manner rather than to enter into a necessarily long theory of design of gear teeth. The association of practice with principles has evidently been his aim throughout and in this he has for the most part succeeded. His illustrations are many and are well chosen, and his writing is of a readily understandable nature.

The book comprises 18 chapters in four sections, the first of which covers the principles of design; the second, methods of gear cutting; the third, machines, including cutters, plainers, milling machines, etc. Section 4, deals with materials, manufacture and strength of gears. An appendix consists of very useful tables for mechanical engineering.

There are several instances where the author does not make himself clear. In one or two cases his terminology is undoubtedly at variance with that which is almost universally accepted. These slips are unimportant, however, and are not misleading to the man familiar with the machinery of gears or the principles of their design. To counteract them he will find a great deal of very useful information with which to supplement his previous knowledge by the later developments in engineering practice.

Roads and Pavements.—By Ira O. Baker, C.E., M.Am.Soc.-C.E., Professor of Civil Engineering, University of Illinois. Published by John Wiley and Sons, New York, Canadian Selling Agents, Renouf Publishing Company, Montreal; 698 pp.; 171 illustrations; size 6 x 9 in.; cloth; price $5.

The second edition of Dr. Baker's treatise on Roads and Pavements is an enlargement upon the previous edition, but the incorporation into it of an additional chapter of over 40 pages on the subject of automobile roads and concrete pavements, and by the bringing up-to-date of the original edition, which will be remembered as having been accepted 10 years ago as an excellent treatise on this subject. In the new edition the concise but comprehensive style of the author is evident throughout. Part 1, deals with country roads, their location, economics of various kinds. It comprises seven chapters. Part 2, contains 14 chapters on street pavements covering economics, design, drainage, foundation, more important kinds and the comparison of them. A chapter is also devoted to sidewalks. In the newly added chapter mentioned above appears a summary of the modern and changed practices which the advent of the motor vehicle has necessitated. It discusses effect of automobiles upon roads; method of suppressing dust; methods of forming a protective covering; construction of bituminous macadam roads and of concrete roads. In the latter various specifications have been summarized. The whole chapter is well condensed and orderly, and adds materially to the value of the book.

Poor's Manual of Railroads for 1914.—Published by Poor's Railroad Manual Company, 535 Pearl Street, New York; 2,052 pp. of text; size 7 x 9 in. This is the 47th annual number of Poor's Standard Manual. It is devoted entirely to steam railroad securities, and is published separately, Poor's Manuals of Public Utilities and of Industrials respectively to be published at a later date.

The special feature this year is the information part given in the manual showing whether or not interest on railroad bonds is payable without deduction for the United States income tax. It contains other new features, including about 500 new comparative and analytical tables, all contributed to assist the investor in forming an opinion of the value of railroad securities. It is needless to say that this manual is the most reliable and carefully compiled work of its kind on the subject of American roads.

Industrial Training and Technical Education. Part 4, of the report of the Royal Commission on Industrial Training and Technical Education, Jas. W. Robertson, Chairman, 770 pp.; 6 x 9 in.; cloth.

This part of the report deals with the inquiry in Canada. The provinces are taken separately. An outline of the educational system of each, provisions for technical instruction, a summary of testimony as to industrial workers, steel, iron and coal, agriculture and agricultural education are divisions typical of the classification of the inquiry.

Canadian Patent Law and Practice.—By Harold Fisher, B.A., LL.B., and Russel S. Smart, B.A., M.E., with an appendix on Canadian Patent Office Practice, by W. J. Lynch, I.S.O.; published by Canada Law Book Company, Limited, Toronto; 478-xxxii. pp.; 6 in. x 9 in., half leather binding; price, $7.50.

There are many ways in which this book will be found of distinct value by not only patent attorneys and solicitors, but by engineers who have frequent occasion to investigate patent claims or regulations respecting them.

The work is divided into 20 chapters, some of them condensed to essentials only, while others go into considerable detail such, for instance, as the sections devoted to infringement, and practice in infringement cases.

The whole question of patent law seems to have been very thoroughly investigated, and although written primarily for the patent lawyer, engineers and manufacturers who are interested in inventions should acquaint themselves of Canadian practice as considered in this book.

An important feature is an appendix by W. J. Lynch, Chief of the Canadian Patent Office, who discusses in detail Canadian Patent Office Practice. The volume also contains copies of standard forms for petitions, specifications, assignments, disclaimers, etc.

The Gyroscope.—By F. J. B. Cordeiro, published by Spon and Chamberlain, New York; 104 pp., illustrated; 5½ x 8½ in.; cloth; price, $1.50.

(Reviewed by A. S. L. Barnes, Hydro-Electric Power Commission of Ontario).

This book is divided into two parts,—"Theory" and "Applications."

The author has a way of making positive statements which arouse in the reader a desire to refute them if possible, and several of them are certainly open to argument. For example, when we are told that the word "torque" is engineering "slang" for "couple," it seems time to raise a protest since the two words are not inter-changeable, the former being the cause and the latter the effect.

Again, it is argued that rotation from right to left should be taken as the positive, or +, direction instead of, as is more usual, the reverse or "clockwise" direction; the reason given being that "in the Northern Hemisphere . . . practically all the motions of nature are to the left—cyclones, heavenly bodies, etc." This question of direction, however, surely depends on the location of the observer; for example, in looking down on the solar system, from an astronomer's point of view, that is, from outside, while considering the North Pole as the top, the author's statement is true, but we are not all astronomers, and it is at least probable that man's universal predilection for what we call right-handed rotation has been due to the fact the apparent direction of rotation of the "heavenly bodies" is in that sense, so that, instead of our clocks and our screws having been made right-handed "by accident," it is much more likely to be traceable to man having had an example of "right-handed" rotation before his eyes throughout the whole period of his existence on this planet—the accident, if there be one, is due to the Creator having arranged, not only the directions of rotations as they are, but also to his having allowed "the greatest population and the highest civilization" to exist on the Northern Hemisphere—had astronomy had its birth in the Southern Hemisphere Mr. Cordeiro would have argued in the opposite sense to what he does now, as then his viewpoint would have been changed and he would have declared that the motions of the heavenly bodies were from left to right.

A considerable portion of the theoretical part of the book is not of direct interest to engineers, as it is devoted to problems of an astronomical nature; in the earlier pages there are, however, several interesting cases of gyroscopic motion treated mathematically which could be readily applied to many engineering problems. In the second part of the book, the writer points out that a train in rounding a curve has two forces tending to de-rail it, the centrifugal action, which is guarded against by raising the outer rail, and also the gyroscopic action of the rapidly revolving, heavy masses of the wheels, which, as is well-known, tends to prevent their being turned out of the plane of rotation. It is asserted that engineers neglect this latter point; if so, they should consider it at once, as the force thus exerted on a long train running at a high speed must be very far from negligible.

Aviation comes in for some remarks, and here it is stated that two motions and two propellers revolving in opposite directions would have the effect of neutralizing the gyroscopic action which is present when only one motion is employed. Makers of aeroplanes might well look into this point as tending to greater flying efficiency.

Following this are descriptions of several practical applications of the gyroscope, such as the Brennan Mono-rail car and the Gyro-compass, etc., which have been described in the technical journals.

Although some little criticism is here given, the book is really interesting, and to anyone dealing with any bodies in which rotational motion plays a part, whether he be an engineer, an astronomer, meteorologist, a designer of guns and projectiles, or even a "sky pilot," in the latest accepted meaning of this term, there are points which, especially if he have a liking for mathematics, will take his attention.

Egyptian Irrigation.—By Sir W. Willcocks, K.C.M.G., F.R.G.S., and J. I. Craig, M.A. (Edin.), B.A. (Cantab.), F.R.S.E., F.R.Met.S., with an introduction by Sir Handbury Brown, K.C.M.G. Published by E. and F. N. Spon, Limited, London, and Spon and Chamberlain, New York. Third edition in 2 volumes; 884 pages, 81 plates and 188 illustrations; cloth. Price, $10.50 net.

To engineers having to do with irrigation, reclamation work and water storage, Egyptian Irrigation presents a very valuable compilation of statistics and details covering the extensive development of the Nile region. The Aswan dam and the Delta Assint, Zifta and Esna barrages, to which Egypt is indebted for its transformation, are known throughout the world for the engineering skill, which their construction has entailed. That "the Egyptian question was the Irrigation question," has been for years a well-known saying, as the influence of irrigation pervades Egyptian economics, politics, social life, agriculture, legislation and even religion.

The work includes the fullest information obtainable of the Nile and its tributaries; together with minute presentations of the problems and their solution, covering some of the most interesting hydraulic questions ever encountered.

Sir William Willcocks, whose engineering work in Egypt dates from 1883, was the author of the first two editions of this treatise. The first was published in 1889, just about the time, according to Milner's "England in Egypt" he, while on an exploration trip for the Minister of Public Works, into Upper Egypt, had occasion to join, and take part in, a Mohammedan thanksgiving service in a mosque at Tahta. Later, as Director-General of Reservoirs, he drew up the designs and estimates of the Aswan dam and Assint barrage. Subsequently he prepared the Cairo drainage project. From 1908 to 1911 he acted as consulting engineer to the Turkish Government and prepared projects for irrigating 3,000,000 acres, and controlling the Euphrates and Tigris. (In connection with this work he is at present in America at the Savannah drainage convention as announced in last week's issue of *The Canadian Engineer*.)

His collaborator, Mr. J. I. Craig, has spent 12 years in Egyptian engineering. He is now Controller of Statistics for the Egyptian Government, and is a distinguished mathematician and meteorologist.

Since the publication of the second edition of Egyptian Irrigation in 1899, all the above-mentioned regulating works, and others both in Upper and Lower Egypt, have been con-

structed, and have been attended or followed by notable results. This new edition completely covers the entire development. It necessarily contains a vast body of facts and figures. Reference to these, however, is facilitated by a system of triple indexing.

Volume I. deals in general with the geology, meteorology, hydrology of the Nile region; the Nile in detail; Basin Irrigation (2 chapters), and Perennial Irrigation (2 chapters). Volume II., has the following chapters: Drainage and land reclamation; the Nile in flood; Engineering details; Barrages; Water storage and flood protection; the Aswan dam; Agricultural; Administrative and legal. Appendices deal with Evaporation; Strength of Egyptian stones and mortars; Salt in various lakes; Discharge diagrams, etc.

The book is not the presentation of the views of one or two men. It contains the opinions of many experts, some of them in direct opposition to those of the author's. As an example, one chapter contains quotations from 10 different experts.

The volumes are well printed and strongly bound. Tables and illustrations are exceptional in their comprehensiveness and clearness. The metric system has been used throughout.

Outlines of Railway Economics.—By Douglas Knoop, M.A., Lecturer on Economics, University of Sheffield. Published by MacMillan and Company, Limited, London, New York and Toronto; 274 pp., 5 x 7 in.; cloth; price, $1.50.

This volume is based for the most part upon a study of the railway industry in Great Britain, although it contains frequent references to railways of other countries, particularly Canada and the United States. Its contents are carefully classified into 21 chapters, each dealing with an important and distinct phase of the application of economic study to railways. Some of these, characterizing the book, are as follows: Application of the law of increasing (and decreasing) returns to railways; Determination of prices under both competitive and monopoly conditions; Fixing of rates and fares, and State regulation thereof; State ownership and management of railways, etc.

In his introductory chapter the author presents the following special reasons for the study of the railway industry:

(1) Railways are of enormous importance in society; on the one hand, transportation has some share, great or small, in the production of all commodities, so that practically all producers and consumers are directly interested in the price of railway services. On the other hand, railways have a great influence on the distribution of population, and are consequently a matter of much social concern.

(2) The railway industry affords illustrations of some of the most interesting problems of price determination; the principle of differential charging can be seen at work in other industries, but nowhere is it so fully acted upon as in the case of railways.

(3) The railway industry, partly owing to its tendency to be monopolistic in character, has been marked out for special attention by the State throughout the world; governments either exercise considerable supervision over railways or actually own them.

Suspension Bridges.—By. Prof. Wm. H. Burr, 1913, published by Messrs. John Wiley and Sons, New York. Canadian Selling Agents, Renouf Publishing Company, Limited, Montreal. 414 pages, 67 text figures and 6 plates. Size, 6 x 9 in., cloth. Price, $4.50 net. Reviewed by David A. Molitor, C.E.

The book comprises eleven chapters and two appendices, devoted to the following subjects:—

Chapter I. deals with an approximate theory of the stiffening truss and the properties of the cable, employing a notation which is not uniform with the other chapters.

Chapter II. treats the statically determinate suspension cable with a three-hinged stiffening truss.

Chapters III. and IV. take up the statically indeterminate suspension cable with continuous and non-continuous straight stiffening trusses, considering the special cases of suspenders absent or present in side spans, using Menabrea's "method of least work." Pages 57 to 122 are practically a translation of pages 5 to 17, of chapter 12, vol. II., part IV., "Der Brückenban," by Prof. J. Melan, in Handbuch der Injenieurwissenschaften. More probably this was taken from the translation given in a "Report on Maximum Span Practicable for Suspension Bridges," 1894, by Major Raymond, Capt. Bixby, and Capt. Edw. Burr. The remainder of chapter IV. is elaborated from the same sources, and pages 175 to 211 are devoted to problems pertaining to the Manhattan Bridge, designed by Mr. Moiseieff.

Chapter V. gives the analysis of the straight stiffening truss, according to the method of deflections, and uses two illustrations applied to the Manhattan Bridge.

Chapter VI. concludes the subject of suspension bridges in the discussion of temperature stresses with applications to the Manhattan Bridge.

Chapter VII. deals with arch ribs by graphics applied to the cases with fixed and hinged ends, with one problem of each class.

Chapter VIII. treats of the arched rib for fixed and hinged ends, by Menabrea's "method of least work," giving an example of the fixed arch. This chapter clearly illustrates the circuitous process of the method of least work when compared with the elegance of the influence line method, according to Mohr, Müller-Breslau, Mehrtens, etc.

Chapter IX. briefly discusses the three-hinged arch rib.

Chapter X. devotes 7 pages to the spandrel braced arch.

Chapter XI. deals with cantilevers by analytical methods. This covers 28 pages of information usually given in standard works, without any numerical applications.

Appendix I. on limiting spans and depths of stiffening trusses, gives conclusions arrived at by Prof. Steinman in 1913.

Appendix II. devotes about 7 pages to formulae for reinforced concrete beams employing a notation radically different from the standard and thus rendering the formulae quite useless until the reader has memorized a notation covering 1½ pages.

As stated in the opening sentence of the Preface, "This book has been written primarily to meet the author's needs in the class room, where the chief requisite is the clear elucidation of general principles in connection with their bearing upon engineering work. The satisfactory accomplishment of such a task is none too easy in the treatment of the more simple statically determinate trusses or other structures, but it is excessively difficult when some statically indeterminate structures are under consideration."

To one familiar with the subject matter treated, it is quite apparent that the author has not achieved his principal aims, "the clear elucidation of general principles," and "to give each main structure a general treatment so as to make one demonstration cover all desired or useful special cases."

The general principles governing all structures involving redundancy have remained entirely out of consideration, and yet these are essential to a clear understanding of any modern methods of analysis, and cover all the general and special cases treated, both of suspension and arch bridges.

No criterion is given by which to judge the nature of any particular structure, that is, to decide definitely upon [illegible] condi-

tions involved. Yet this question alone determines the nature and difficulty of the stress analysis, and depending upon the choice of the redundant conditions, the problem becomes difficult or relatively simple, though the general laws and methods remain the same.

The first important step then would be to classify structures according to their degree of redundancy, and then to apply the general method of analysis for statically indeterminate structures. Without these preliminary steps, the solution in its special form loses its comprehensiveness and the reader fails to grasp the broad principles underlying the analysis.

To elucidate this point more clearly, the general process may be briefly sketched as follows: For any number of redundant conditions, X_a, X_b, X_c, etc., any function of the structure, as a moment M, shear Q or stress S may be expressed by general equations, thus:—

$$\left.\begin{aligned} M &= M_0 - M_a X_a - M_b X_b - M_c X_c, \text{ etc.} \\ Q &= Q_0 - Q_a X_a - Q_b X_b - Q_c X_c, \text{ etc.} \\ S &= S_0 - S_a X_a - S_b X_b - S_c X_c, \text{ etc.} \end{aligned}\right\} \quad \ldots (1)$$

These are applicable to the principal frame, derived from the given structure by removing as many members or external supports X, as may be necessary to convert the given structure into a statically determinate one. The quantities with zero subscripts are, therefore, found as for a beam or truss without redundancy, while the $X's$, which may be moments, stresses, or reactions, represent the unknown redundant conditions. These $X's$ depend upon the elasticity properties of the material and cannot be evaluated by the methods of statics, while all other subscript bearing quantities can be readily found by statics applied to the principal frame.

For every structure there exist as many elasticity condition equations as there are redundant conditions, thus making the problem solvable after evaluating the $X's$ by one of the following methods.

I.—Elasticity condition equations in terms of certain determinable stresses according to Prof. Mohr's work equations, where $l/EF = \rho$, as follows:—

$$\left.\begin{aligned} \delta_a &= \Sigma S_a S_0 \rho - X_a \Sigma S_a^2 \rho - X_b \Sigma S_a S_b \rho - X_c \Sigma S_a S_c \rho + \Sigma S_a \epsilon t l. \\ \delta_b &= \Sigma S_b S_0 \rho - X_a \Sigma S_b S_a \rho - X_b \Sigma S_b^2 \rho - X_c \Sigma S_b S_c \rho + \Sigma S_b \epsilon t l. \\ \delta_c &= \Sigma S_c S_0 \rho - X_a \Sigma S_c S_a \rho - X_b \Sigma S_c S_b \rho - X_c \Sigma S_c^2 \rho + \Sigma S_c \epsilon t l \end{aligned}\right\} \quad \ldots (2)$$

II.—Elasticity condition equations in terms of certain determinable deflections according to Prof. Maxwell, thus:—

$$\left.\begin{aligned} \delta_a &= \Sigma P_m \delta_{ma} - X_a \delta_{aa} - X_b \delta_{ab} - X_c \delta_{ac} + \delta_{at}. \\ \delta_b &= \Sigma P_m \delta_{mb} - X_a \delta_{ba} - X_b \delta_{bb} - X_c \delta_{bc} + \delta_{bt} \\ \delta_c &= \Sigma P_m \delta_{mc} - X_a \delta_{ca} - X_b \delta_{cb} - X_c \delta_{cc} + \delta_{ct}. \end{aligned}\right\} \quad \ldots (3)$$

There will always be as many such equations of the form (2) or (3) as there are redundant conditions X.

Owing to the innumerable values of the variable $X's$ required to solve any case for moving loads, the only practicable solution for statically indeterminate structures, even those of the first degree, is by the method of influence lines as first given by Prof. Mohr. The solution is reduced to its simplest possible form by a judicious choice of the redundant conditions as proposed by Prof. Müller-Breslau, by which certain terms of equations (2) or (3) are reduced to zero, thus saving the laborious solution of simultaneous equations.

However, it is not the writer's purpose to do more than to show the broader aspect of this subject which the author has tacitly passed over, and which is of the utmost value in rendering the subject intelligible.

The complexity of the suspension problem in a general treatise is not so much in the solution of the individual case, as in the innumerable variety of possible and feasible cases which exist. Thus any form of truss, arch or cantilever can be combined with a suspension cable, an eye-bar chain or a braced chain.

The author deals with only three general combinations of cables with straight stiffening trusses; 1, girder, with centre hinge; 2, simple girder on two supports; 3, continuous girders. These comprise merely the ordinary types in use. Prof. Müller-Breslau in his Graphische Statik, treats 17 cases without exhausting the subject.

Little or nothing is said regarding the stresses in the individual members of the stiffening trusses, or of braced arches, except for the two-hinged braced spandrel arch. Yet this is quite an important part of the subject and constitutes the real problem after the redundant conditions are solved.

The questions of economic shape and critical sections of an arch rib are not answered, yet a knowledge of these matters is most essential in procuring practical designs with a minimum af labor. It is the writer's experience also, that the "Method of least work" more properly deserves the name "Method of most labor."

The illustrative problems given are not sufficiently comprehensive to serve as complete examples, leaving a great deal to be supplied by the reader in planning actual computations.

While influence lines are employed to a limited extent, far greater use should have been made of these in the analysis of stresses. For the structures treated are precisely those which should be treated by influence lines in preference to any other method.

The style of the book is of uniform excellence with the Wiley publications, though the full-page plates are poorly drawn.

No bibliography is given, and with very few exceptions, only the names of those offering direct assistance to the author are mentioned.

It is rather difficult to understand why students should devote much time to the study of suspension bridges when there is so much fundamental work crowded out by the already overfilled curriculum. On the other hand, the few engineers who may accidentally have to deal with this subject, will do well to consult those authors who have dealt more exhaustively with statically indeterminate structures in general, and suspension bridges in particular.

PUBLICATIONS RECEIVED.

Temiskaming and Northern Ontario Railway Commission. 12th annual report, for the year ending October 31st, 1913.

Electric Switches for Use in Caseous Mines.—By H. H. Clark and R. W. Crocker, United States Bureau of Mines, Bulletin No. 68, 38 pp., illustrated. A study of methods for preventing switching flashes from igniting gases surrounding the switch.

Specifications for Open-Hearth Steel Cirder and High Tee-Rails, as adopted by the American Railway Engineering Association, and by the American Society of Testing Materials. Issued in pamphlet form by Robt. W. Hunt and Co., Limited, McGill Building, Montreal.

Illinois Water Supply Association.—Proceedings of the 6th meeting of this Association, held at the University of Illinois, March 9th to 11th, 1914, containing reports of committees, papers, discussions and general society affairs. 240 pp., illustrated, 6 x 9 in.; cloth.

Sampling and Examination of Mine Cases and Natural Gas.—By George A. Burrell and Frank Seibert, issued as bulletin No. 42, of the United States Bureau of Mines, 116

pp., illustrated. It takes up the collection and analysis of samples and gives a full description of the apparatus and methods used in the various operations.

Tests on Concrete in Sea Water—Progress report of an investigation made by the Aberthaw Construction Co., and H. L. Sherman, Boston, at the United States Navy Yard, Charlestown, Mass., to determine the effect, both mechanical and chemical, of the action of sea water and varying temperatures upon concrete piers of varying composition. Specimens made and immersed early in 1909 were recently examined. A 36 pp., illustrated booklet discloses the observations made.

Preparation of Metallic Cobalt by Reduction of the Oxide.—By H. T. Kalmus, B.Sc., B.H.D., published by the Mines Branch, Department of Mines, Canada, and covering research on cobalt and cobalt alloys conducted at Queen's University, Kingston, 36 pp., illustrated, describing preparatory treatment, methods and apparatus, and reduction with carbon, carbon monoxide, hydrogen and aluminium at various temperatures. The bulletin forms Part 1 of a series of 6 on the study of cobalt.

Trent Watershed Survey.—By C. D. Howe and J. H. White, with an introductory discussion by B. E. Fernow, Dean, Faculty of Forestry, University of Toronto. Published by the Committee on Forests, Commission of Conservation, Canada. 156 pp., illustrated, size 6 x 9 in.; cloth.

This is a report on the conditions in the Trent Watershed and recommendations for their improvement. It outlines the procedure of the survey, its results, etc. One section of the book is devoted to physiographic and forests conditions, including drainage, topography, geology, soils, etc., and a discussion of the financial losses due to forest fires. Another section is devoted to the mechanical and industrial conditions covering farming, lumbering, tourist traffic and social conditions. The book is accompanied by five appendices.

Conservation of Coal in Canada.—By W. J. Dick, M.Sc., Mining Engineer, published by the Committee on Minerals, Commission of Conservation, Canada. 212 pp., 6 x 9 in., illustrated with photographs, maps and diagrams; cloth.

In his report Mr. Dick reviews a full investigation of the coal situation in Canada. Its dependence on the United States for its supply of anthracite coal is one of many points strongly brought out. The development of electric power in the lignite fields of Western Canada is recommended. The manufacture of coal briquettes in other countries is described in detail and the methods adopted to conditions in Canada are indicated. Comparisons are made between the beehive ovens and the by-product ovens for the coking of coal and the economies effected by the latter over the former are clearly presented. Descriptions are given of the principal coal mines in Canada.

The book will be found of great value, not only to those directly engaged in coal mining, but to all who are interested in the economic development of a country.

Good Roads Year Book, 1914.—J. E. Pennybacker, editor, published by the American Highway Association, Washington, D.C., 500 pp., illustrated, 6 x 9 in.; cloth; price $1.

The 1914 Good Roads Year Book is very comprehensive in its collection of data for road men of the United States. It is issued annually by the Association as part of its campaign throughout the country for an adequate system of improved highways. A considerable portion of the volume is devoted to state aid and local road legislation, digests of various road, automobile and convict laws, etc. It contains a complete list of patents issued in 1913 pertaining to roads; a list of bulletins, circulars and documents published in the interests of road builders; a reference list of papers, addresses and magazine articles published in 1913 on the subject of roads. It synopsizes the academic courses in highway engineering of the various universities and colleges, and catalogues the various road associations. The work in different states and the progress of road improvement are featured, while a chapter deals with the important events in the road movement during 1913.

CATALOGUES RECEIVED.

Welding and Cutting Plants.—A 16 pp. catalogue of equipment for acetylene welding issued by Waterhouse Welding Co., Boston, Mass.

Air Compressors.—A 48 pp. leaflet issued by the Canadian Ingersoll Land Co., Montreal, outlining some advantages in their Class "N" compressors.

Aneroids.—A small catalogue circulated by the Topley Co., Ottawa, descriptive of watch and pocket aneroid barometers of "Tycos" make.

Ironclad-Exide Battery.—A sketch of the development of this type of battery in a 24 pp. booklet issued by the Canadian General Electric Co., Toronto.

Cranes for Wharves and Docks.—A pamphlet illustrating typical uses of Demag Cranes, issued by the Deutsche Maschinenfabrik A-G Duisburg, Germany.

Duntley Electric Tools.—An 8 pp. bulletin of Chicago Pneumatic Tool Co., describing portable drills, grinders, spike drivers, etc., for street and interurban railway use.

Mining Tools.—Bulletins Nos. 152-3 and 4 of the Chicago Pneumatic Tool Co., Limited, illustrating their drills, sinkers and stopers, together with the accessories for each.

Railway Motor Gears and Pinions.—20 pages descriptive of forged, solid and split cast-steel gears, pinions, etc. Circulated by the Canadian General Electric Co., Toronto.

Aston Fans.—A 24 pp. illustrated catalogue issued by Veritys, Limited, London, E.C., dealing with the Aston range of ceiling, desk, bracket, ship, railway and saloon fans and blowers.

Small Direct Current Generators.—Bulletin No. A-4188, descriptive of type CVC small, belted, direct current generators; illustrated, 12 pp., issued by Canadian General Electric Company, Toronto.

Montezuma Asphalt.—A beautifully illustrated booklet of 56 pages, issued by the Warner-Quinlan Asphalt Co., New York, describing the qualities and illustrating many streets and roads upon which Montezuma asphalt has been used.

"Steele" Buildings.—A bulletin issued by the William Steele and Sons Co., engineers and contractors, Philadelphia, illustrating a large group of industrial buildings in the design and construction of which that company has had to do.

Chain-Blocks.—A 4 pp. pamphlet illustrating and describing the Morris travelling spur gear chain-block of different types showing saving of headroom due to special design, issued by the Herbert Morris Crane and Hoist Company, Toronto.

Pneumatic Appliances.—An 80 pp. catalogue of air compressors, air hoists, air cranes, pneumatic and hydro-pneumatic elevators, trolleys and trolley systems, and sand blasts fully illustrated, issued by the Curtis Pneumatic Machinery Co., St. Louis, U.S.A., as catalogued No. 62.

Dudbridge Gas Engines.—These types of variable admission gas engines and of gas producing plants are described in a 28 pp. illustrated catalogue issued by Dudbridge Iron Works, Limited, Stroud, England. It shows diagrammatically the construction of the various types and parts, and contains tables of dimensions of capacities, speeds, weights, etc.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

OTTAWA BRANCH, CAN. SOC. C.E.

The closing meeting for the year of the Ottawa branch of the Canadian Society of Civil Engineers was held on Thursday evening, April 23rd.

Mr. C. A. Magrath, C.E., Member of the International Joint Commission and Chairman of the Ontario Highways Commission, gave a short address on "The Engineer and His Profession."

BRITISH COLUMBIA ASSOCIATION OF LAND SURVEYORS.

The British Columbia Association of Land Surveyors has announced the following successful candidates as a result of recent preliminary examinations; G. V. Atkins, R. R. Browne, F. H. Blunt, C. Carswell, G. C. Dunsford, C. N. Dean, G. A. Earle, E. D. Fort, A. B. Fraser, G. F. Heaney, A. D. C. Herne, L. Held, J. L. L. Johnston, W. M. Myers, J. A. McCulloch, J. D. Slaven, F. W. Stevens, N. T. Townsend, R. P. Thomson, and R. S. Wood.

"SUBAQUEOUS TUNNELLING."

This was the subject of a paper read on the evening of April 23rd by Paul Seurot, C.E., chief engineer of Jacobs and Davies, Montreal, at a general meeting of the Canadian Society of Civil Engineers.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

INTERNATIONAL CONFERENCE ON CITY PLANNING to be held in Toronto, May 25-6-7, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

PERSONALS.

J. A. SKERTCHLY, an English mining engineer, is visiting British Columbia to report on gold properties.

GEO. W. CRAIG, City Engineer of Calgary, recently delivered a very interesting and attractive lecture on city planning in that city.

W. S. HARVEY has discontinued his connection with the city of Lethbridge as its acting city engineer, owing to its having adopted commission control of civic affairs. Mr. Harvey is at present in Eastern Canada.

J. W. EVANS, of Belleville, has recently been appointed city engineer of that place, to fill a vacancy of over a year's standing. Mr. Evans, who is president of the Tivani Steel Company, of Belleville, was previously associated with the Bay of Quinte Railway as engineer.

FREDERICK W. COWIE, chief engineer of the Montreal Harbor Board, was recently awarded the Telford gold medal by the Institution of Civil Engineers of Great Britain for his paper, entitled "Transportation Problems in Canada and the Montreal Harbor," read on April 7th. His paper appears in extract form in another part of this issue.

G. N. GUEST, A.M.I. Mech. E., M.I.H.V.E., director of Hollings and Guest, Limited, of Birmingham, England, engineers and manufacturers of hydraulic presses, pumps, accumulators, etc., will visit Canada at the end of May. Mr. Guest will tour the country thoroughly, visiting all the principal towns and cities.

F. A. YERBURY, M.I. Mech. E., manager of the Heaps Engineering Company, Limited, Vancouver, B.C., has resigned and expects to return to England about the end of May. Mr. Yerbury has been in Canada for a number of years. He was formerly manager of the Canadian Boving Company, and while with that firm he introduced the Diesel engine into Canada. Mr. Yerbury will devote his time to inspection work throughout Europe for Canadian and American firms, also reporting on European machinery, methods and progress.

OBITUARY.

As the result of the capsizing of a small boat in the Fraser river, near Lytton, B.C., Messrs. E. T. Shaw, R. M. Horton and H. Burniston, three engineers on Canadian Northern Railway construction, were drowned last week. Mr. Shaw was a son of Mr. H. S. Shaw, of Ottawa, and was division engineer of that section.

The death is announced at Burlington, Ont., of Mr. William White, whose connection with engineering as a contractor is known to many. Mr. White carried out a number

of contracts for the Government, among them being the timber works at Sault Ste. Marie new locks, and the C.P.R. trestles on the north shore of Red Sucker Cove. He built piers at Port Colborne and many other places, also many bridges throughout Ontario.

The death occurred on April 19th of Alfred Noble, C.E., a very prominent member of the engineering profession in New York. His career was a most interesting one, and typical of that of many great men of the profession who rank as nation-builders. Among his many activities in engineering work were the following: From 1868 to 1870 he was assistant engineer on river and harbor work on the Great Lakes. From 1870 to 1872 he was in charge of improvements on St. Mary's Falls canal and St. Mary's river. During this time the first great masonry lock at the Sault, then by far the largest canal lock in the world, was built. On completion of this work he became resident engineer on the construction of an important bridge at Shreveport, La., over the Red River. From 1883 to 1886 he was general assistant engineer, Northern Pacific R.R. From 1886 to 1887 he was resident engineer on the construction of the Washington bridge over the Harlem River; at that time the largest arch bridge in existence. From 1887 to 1894 he was resident engineer on the construction of several bridges over the Mississippi at Memphis and Alton, over the Missouri at Bellfonton and Leavenworth, over the Ohio at Cairo. He was appointed a member of the Nicaragua Canal Board, which visited Central America and examined the route of the Nicaragua Canal, and also the Panama Canal.

In 1899 he became a member of the Isthmian Canal Commission, which was charged with the selection of the best canal route across the isthmus, and it has been substantially on the route selected by this Commission that the Panama Canal has been constructed.

In 1905 he was appointed a member of the International Board of Engineers to recommend whether the Panama Canal should be constructed as a sea-level or a lock canal. This Board consisted of thirteen members, of whom five were nominated by foreign countries. Mr. Noble was one of the minority of five Americans who recommended the adoption of the lock-level plan. Their views were adopted by the Government and the Canal has been built in accordance with their recommendations.

In March, 1907, he was one of the three to visit the Panama Canal to investigate the conditions regarding the foundations of some of the principal structures. Mr. Noble was continuously identified with the Canal project and deserves much credit for the solution of its engineering problems.

In July, 1897, he was appointed a member of the United States Board of Engineers on Deep Waterways, which made surveys and estimates of cost for a ship canal from the Great Lakes to deep water in the Hudson River. In November, 1901, the city of Galveston, Texas, appointed Alfred Noble, along with Henry C. Ripley and General Robert, as a Board of Engineers to devise a plan for protecting the city and suburbs from future inundation. From 1902 to 1909 Mr. Noble was chief engineer of the East River Division of the New York extension of the Pennsylvania R.R., and was in entire charge. Since 1909 he engaged in general practice as a consulting engineer. Probably the most important work dealt with was in relation to the dry docks built for the United States Government near Honolulu. He was also for a time consulting engineer to the Quebec Bridge Board, to the Board of Water Supply, New York City, and to the Public Service Commission of the State of New York.

He has been Past President of the Western Society of Engineers, American Society of Civil Enginers, and American Institute of Consulting Engineers, and an Honorary Member of the Institution of Civil Engineers of Great Britain.

Coast to Coast

Regina, Sask.—A considerable reduction in power rates will probably go into force in Regina within the near future, the civic utilities committee having decided to grant various concessions in the interests of the power user.

Toronto, Ont.—It is reported that an agreement has been effected between the G.T.R. and C.P.R. companies in connection with plans for the Toronto Union Station. These will be submitted to the Dominion Railway Board about May 15. The matter of the viaduct construction has not been finally decided, and will be given later consideration. The cost of the Union Station is estimated at between $12,000,000 and $15,000,000, and that of the viaduct at $3,000,000.

Ottawa, Ont.—The Railway Commission has considered the proposition of the building of the proposed "All Red Line Railway" with a total projected length of 3,270 miles, and has cut it down to a line of but 1,000 miles in length to run from Cape St. Charles on the Labrador coast, to the city of Quebec. The name of the railway was changed to "The Labrador, Quebec and Southern Railway," and the capital stock was reduced from one hundred millions to ten millions. The line, as now authorized, will run west from Cape St. Charles to the Peribonka River, 600 miles; then through the valley of the Peribonka River to a point on Lake St. John, 200 miles further, and then on to the city of Quebec.

Montreal, Que.—The Montreal board of control for the present fiscal year has voted sums amounting to $2,789,907 for public works which have been recommended by Chief Engineer Janin. Of this amount $1,500,722 is to be expended on pavements, $915,545 on sewers and $373,640 on waterworks. The sewer allowance is divided as follows: $31,345 for the East division, $639,500 for the West division, and $244,700 for the North division. The amount for paving is divided as follows: $387,410 for the North division, $621,254 for the West division, and $492,057 for the East division, and the appropriation for the waterworks department is to be used as follows: main pipe $125,000, new services in all sections of the city $65,000, hydrants $27,000, meters $30,000, pipes to relieve strain on present pipes $86,175, and $40,465 for the cost of installing pipes.

Winnipeg, Man.—The season's programme of railway construction in Manitoba, Alberta and Saskatchewan has been definitely decided. The C.P.R. will proceed with the grading which is being done on the 15-mile extension of the Moose Jaw south-west branch beyond Expanse, and will also lay steel upon the same. Also grading will be done on a further 25-mile extension of the line proceeding from Sterling East, though steel may not be laid this year. The C.P.R. will also proceed with grading operations as follows: 72 miles on the Monitor-Kerr Robert line, 25 miles Suffield south westerly, 87 miles on the line running west of Weyburn, 25 miles on a line running north westerly from Coronation, and 126 miles on the line from Bassano easterly. The G.T.P. operations will be largely confined to the branch into Prince Albert from Young, Sask., and the track laying on the Brandon branch in Manitoba. The main line in British Columbia will be completed. On the C.N.R., construction work will be done on the Peace River line from Onoway on the main line north-westerly; also on a line on the north side of the Saskatchewan River extending from Oliver to meet the branch running west from North Battleford. Work will be in progress on the Calgary-Lethbridge branch, on the Elrose to Alsack branch on the Gravelbourg-Swift Current line, on the extension of the Thunder Hill branch, and on the branch from Wroxton to Yorkton.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21632—April 11—Approving location C.N.O.R. station grounds at Lac a Travers, mileage 140.8 from Ottawa, Division "E," Twp. White, Dist. Nipissing, Ontario.

21633—April 11—Approving, subject to terms of consent of Twp. of Verulam, location of platform and shelter of C.P.R. (Lindsay, Bobcaygeon and Pontypool Ry.) at mileage 36.0, Bobcaygeon Sub. Div., in Lot 13, Con. 7, Tp. of Verulam, Co. Victoria, Ont.

21634—April 14—Reporting to Governor-in-Council for sanction By-law No. 13, approving "General Train and Interlocking Rules," for observance by officers and employees of Dominion Atlantic Railway Company, in operation of its railway.

21635—April 14—Authorizing C.L.O. and W. Ry. (C.P.R.) to take, without consent of owner, certain lands in town of Oshawa, for purpose of affording access to diversion of Albert Street, said town.

21636—April 14—Authorizing C.P.R. to use bridge No. 18.7 on St. Gabriel Subdivision, Eastern Division.

21637—April 14—Authorizing C.P.R. to operate over bridge No. 11.3, Standbridge Subdivision, Eastern Division, Que.

21638—April 15—Approving location Pacific and Hudson Bay Ry. from Bella Coola Harbor to Hagensborg, B.C., mileage 0 to 10, Coast Dist.

21639—April 14—Authorizing Lake Erie and Northern Ry. to construct bridge over Western Counties Canal, station 3.00, at Brantford, Ontario.

21640—April 8—Authorizing T.H. & B. Ry. to take certain lands situate in Twp. Pelham, Co. Welland, Ont., for purpose of providing two or more team tracks upon such lands.

21641—April 15—Authorizing C.N.R. to cross and divert public highway on S.W. ¼ Sec. 19-10-30, W. P. M., mileage 76, Kipling Subdivision.

21642—April 14—Authorizing C.N.R., at its own expense, to construct and maintain a highway crossing over its railway on Second St. North, in S.E. ¼ Sec. 1-47-6, W. 3 M., Townsite of Leask, Sask.

21643—April 14—Directing that, within 60 days from date of this Order, G.T.R. install stop blocks on sidings on its line at east side of Cherry Street, Toronto, Ontario.

21644—April 9—Authorizing, subject to terms contained in paragraphs 1 and 2, Bylaw No. 9 of Town of Goderich, G.T.R., to construct siding into premises of American Road Machine Co. of Canada, Limited.

21645—April 14—Authorizing G.T.R. to use and operate bridge No. 257, mileage 25.25, 13th Dist. in Town of Milton, Ont.

21646—April 14—Amending Order No. 19646, dated May 16th, 1913, by striking out all words after word "Caution," in fifth line of operative part of Order, and substituting therefor following, namely: "All trains must come to a full stop at that semaphore and then proceed to the home semaphore and there be governed by the rules governing the operation of interlocked signals."

21647—April 16—Approving revised location G.T.P. Branch Lines Co., Battleford Branch, through N.W. ¼ Sec. 4-43-16, W. 3 M., Sask.

21648—April 15—Approving revised location G.T.P. Branch Lines Co.'s station at Coalspur, mileage 35.8, Alberta Coal Branch, in Sec. 33-48-21, W. 5 M., Alberta.

21649—April 16—Amending Order No. 21537, dated March 23rd, 1914, by striking out figures and letters "19th" [illegible] second line of description of bridges, under heading "District," and substituting therefor figures and letters "20th."

21650—April 15—Authorizing C.N.O.R. to construct bridge over Raimbault Creek, Parish St. Laurent, Co. Jacques Cartier, Que., mileage 48 from Hawkesbury; and rescinding Order No. 19657, dated June 21st, 1913.

21651—April 15—Approving location C.N.R. extension of Swift Current Line through Tp. 15-10 and 12, west 3rd, Meridian, Sask., mileage 124.96 to 142.53.

21652—April 17—Authorizing C.P.R. to construct spurs for F. A. Fish, from a point on easterly limit of right-of-way Main Line, mileage 26.62, Orangeville Subdivision, Ont. Div. in Lot 14, Con. 3, west of Hurontatio St., Township of Caledon, Co. Peel, Ont.

21653—April 17—Directing that, within 30 days from date of this Order, G.T.P. Ry. re-appoint station agent at Zelma, Sask.

21654—April 18—Authorizing C.P.R. to construct road diversion in Sec. 22-36-11, W. 4 M., Alta., and construct, by means of grade crossings, tracks of Swift Current Northwesterly Branch line across eleven (11) highways, mileage 0.0 to 13.0 of said Branch Line.

21655—April 16—Authorizing, subject to terms of resolution, Esquimalt and Nanaimo Ry. to construct siding to property of B. C. Pottery Co., at Esquimalt, B.C.

21656—April 16—Relieving G.T.R. from providing further protection as crossing of St. Patrick St., village of Port Dover, Ontario.

21657—April 17—Granting leave to Hamilton Cataract Power, Light and Traction Co., Limited, to erect, maintain and place 2,400-volt overhead distribution circuit over G.T.R. branch line at Ferguson Ave., north of Barton St., Hamilton, Ont.

21658—April 15—Approving and authorizing, subject to condition that company keep its employees off sides of cars on freight shed side, clearances as shown on plan of an overhead platform runway to serve tracks of T.H. & B. Ry. on north side of Forest Ave., Freight House, city of Hamilton, Ont.

21659—April 18—Authorizing C.N.O.R. to construct across Castle Crescent Road in Lots 36 and 37, Con. 3, F. B., Tp. York, Co. York, Ont., by means of structure carrying highway over railway.

21660—April 17—Authorizing C.N.R. to cross and divert two (2) highways on Maryfield Branch, Sask., namely,—South Road Allowance between Secs. 7 and 8-26, W. 2 M.; and Highway between Secs. 19-5-27, W. 2 M., and Sec. 24-5-28, W. 2 M.

21661—April 16—Authorizing Montreal and Atlantic Ry. Co., to construct siding for Bedford Manufacturing Co., Bedford, Que., from point on westerly limit of right-of-way, mileage 11.16, Stanbridge Subdivision, thence southwesterly across Lots Cadastral Nos. 1315, 1314, 1313, 1310, 1304, 1302 and 1303, Rge. 7, Tp. Stanbridge, Co. Missisquoi, Quebec.

21662—April 16—Authorizing Western Canada Power Co., Limited, to construct spur from point on main line, running through Langley Indian Reserve No. 2, crossing a highway in the Mission Dist. Mun., to connect with trestle in the Stave River, B.C.

21663—April 15—Authorizing Montreal and Atlantic Ry. to construct spur for B. R. Stevens, town of Bedford, Que.

21664—April 17—Authorizing C.P.R. to construct, at grade, tracks of wye at mileage 230.0 on Weyburn-Stirling Branch, across road allowance between Secs. 8 and 17, Tp. 8, Rge. 18, W. 3 M., Sask.

21665—April 17—Authorizing C.P.R. to construct alterations and extensions to tracks at Hardisty St., Fort William, Ont.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

PROPOSED T. & N. O. TERMINAL ON JAMES BAY

As outlined in an address to the Toronto Branch, Canadian Society of Civil Engineers, March 26th, 1914

By J. G. G. KERRY,

Consulting Engineer, T. & N. O. Ry. Commission; President Kerry & Chace, Limited, Toronto

[The subject matter of this article consists of a general review of the engineering work that has been done up to date preparatory to the establishment of a railway terminal on the shores of James Bay. It has been gathered together on the direct instruction of the Commission that has charge of the operations of the Timiskaming & Northern Ontario Railway; and it is good evidence of the forethought shown by the Commission in preparing for the carrying out of a project that must shortly be of great public importance. Mr. Kerry states that the work of preparing this information has been entirely under the direction of the Chief Engineer for the Commission, S. B. Clement, B.A. Sc., M. Can. Soc. C.E., and his staff, who are entitled to much credit for the careful and thorough manner in which the necessary data connected with the project has been gathered together.—EDITOR.]

THE construction of the Timiskaming and Northern Ontario Railway was commenced about the year 1900, the enterprise being undertaken by the Provincial Government of that date in a somewhat blind compliance to the popular demand that a very definite effort should be made to open up the large and unknown area of land that lay to the north of the main line of the Canadian Pacific Railway and between the north shore of the Great Lakes and the south shore of Hudson's Bay. Almost simultaneously, the Provincial Government sent out a number of exploring parties throughout this area. These parties were in charge of various members of the Ontario Association of Land Surveyors, and from their reports the province first learned of the existence of that large area of arable land that is now known as the Clay Belt, and shown in Fig. 1.

Fig. 1.

The importance of this so-called Clay Belt, not only to the Province of Ontario but to the Dominion of Canada at large, cannot be over-estimated. A study of the geographical distribution of our population at the present time will show that it consists of one large and rapidly growing unit which is located entirely to the west of the line of Lake Winnipeg. A second and larger unit is located entirely to the south and east of a line joining Orillia and Pembroke. The district lying between these two lines, with the exception of such towns as North Bay, Sudbury and Port Arthur, may be said to be entirely unsettled; this was absolutely true little more than 10 years ago, and in large measure remains true to-day. A possible result of the existence of so definite a cleavage in the settlement of the Dominion is the growth of a distinct west and a distinct east. From a national point of view this, more than any other one thing, is what we all desire

to prevent and no effort should be spared that will tend to keep this possibility from becoming a reality.

Examining a map, such as Fig. 1, upon which the outline of the Clay Belt is marked, it will be seen that this Belt, which consists of most fertile land, stretches almost half way across the unsettled area which at present divides the Dominion. The speaker, therefore, regards the work of the commission in opening up the Clay Belt for settlement as possibly the most important national work now in progress in Canada.

Other organizations are also active in this work of development; the Algoma Central Ry. is building in from the south and west; the National Transcontinental Ry. and the Canadian Northern Ry. are traversing the Belt from west to east. The next work of importance would, therefore, appear to be the establishment of an outlet to the north and the establishment of a rail connection with the only ocean coast line within the confines of the Province of Ontario. With such an end in view the commission has directed the carrying-out of the investigations that are discussed in this paper.

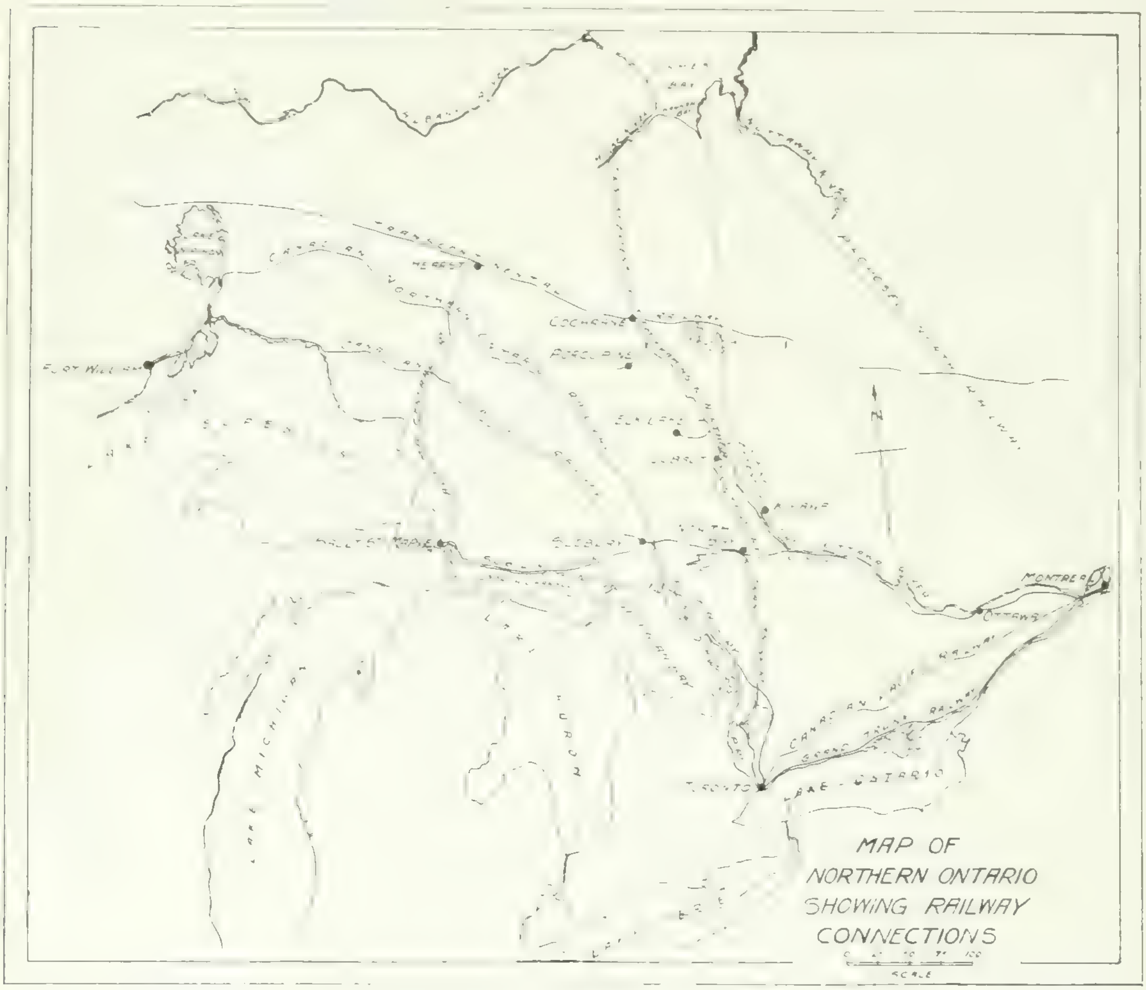

Fig. 2.

The most attractive location for the proposed terminal so far as present information goes, is at the mouth of the Moose River, as shown in Fig. 2, and this point may be referred to as Moose Harbor. It may be remarked that by far the larger portion of the Clay Belt is drained by the tributaries of the Moose River and that the natural movement of traffic will be along the line of these tributaries with a natural point of concentration at the harbor. Geographically speaking, Moose Harbor is not an isolated point and does not lie in an extreme corner of the possible confines of civilization. If on Fig. 1 a half circle is drawn with the harbor as centre it will be found that, without very material change of radius, Winnipeg, Port Arthur, Toronto, Ottawa, Montreal and Quebec can be reached, and it may reasonably be expected that in the not-distant future a commercial centre of some importance will exist near the harbor, and that this centre will transact business directly and independently with each of the cities that have just been mentioned.

A journey from Toronto to Moose Harbor after the completion of the railway extension will not be an arduous undertaking The distance can readily be run within 24 hours, and, as a matter of illustration, the run may readily be compared to the present journey from Montreal to Chicago, or from Toronto to Port Arthur; in each case the distance between the points mentioned is rather greater than the distance from Toronto to Moose Harbor will be, this distance being roughly estimated at 670 miles.

The enterprise of extending the Timiskaming and Northern Ontario Railway to the Bay must be regarded as one of colonization and development; it is not possible to prove from statistics of present traffic that the undertaking will be a commercial success, the simple fact being that no traffic at present exists, although there is every reason to believe that natural resources abound from which an important traffic can be created.

The tributary district to the railway will consist not only of the Clay Belt, but also of the well-defined area of clay lands lying along the shores of James Bay, and geologically known as the Coastal Plain. The soils of this Plain bear much resemblance to those of the Clay Belt, and their development presents in a larger degree the same problems that have to be dealt with in the development of the Clay Belt. Where satisfactory means of drainage exist, the growth of the various species of northern timber proves the fertility of the soil, but the geologists regard the whole district, and particularly the Coastal Plain, as being of very recent creation, placing the period of its elevation above sea level at not more than 10,000 years. The drainage system is, therefore, quite imperfectly developed and large areas of land are buried under muskeg and

moss. The condition is indeed very similar to that which exists on the prairies to the east of Winnipeg, the lands being so flat-lying that their slope is not sufficient to provide for the quick discharge of the melting snows in the spring and the formation of muskegs and swamps naturally follows. The natural slope of the lands is, however, sufficient to enable the engineers of the future to design and construct drainage works on a comprehensive scale that will be perfectly satisfactory in their operation, and with the construction of such works practically the entire area of the district will become available agricultural land.

Much of the district is already efficiently drained by the natural watercourses, and the colonizing energy of the province is for the present being concentrated on the settlement of these lands. In general, such lands carry a healthy growth of spruce wood of sufficient size to be valuable as raw material for pulp and paper mills. Intelligent development of such lands, therefore, provides work for the settler both in summer and in the winter. The clearing-up of the lands is, comparatively speaking, easy work, and the timber as it is cut finds a ready market.

The tributaries of the Moose River have direct courses on their way to the Bay and a relatively heavy fall per mile. As a consequence, numerous sites are found where water power can be cheaply developed, and one of the early industries of the district will be the manufacture of pulp and paper. This has been already undertaken on a large scale at Iroquois Falls which itself is not distant more than 200 miles from the Bay.

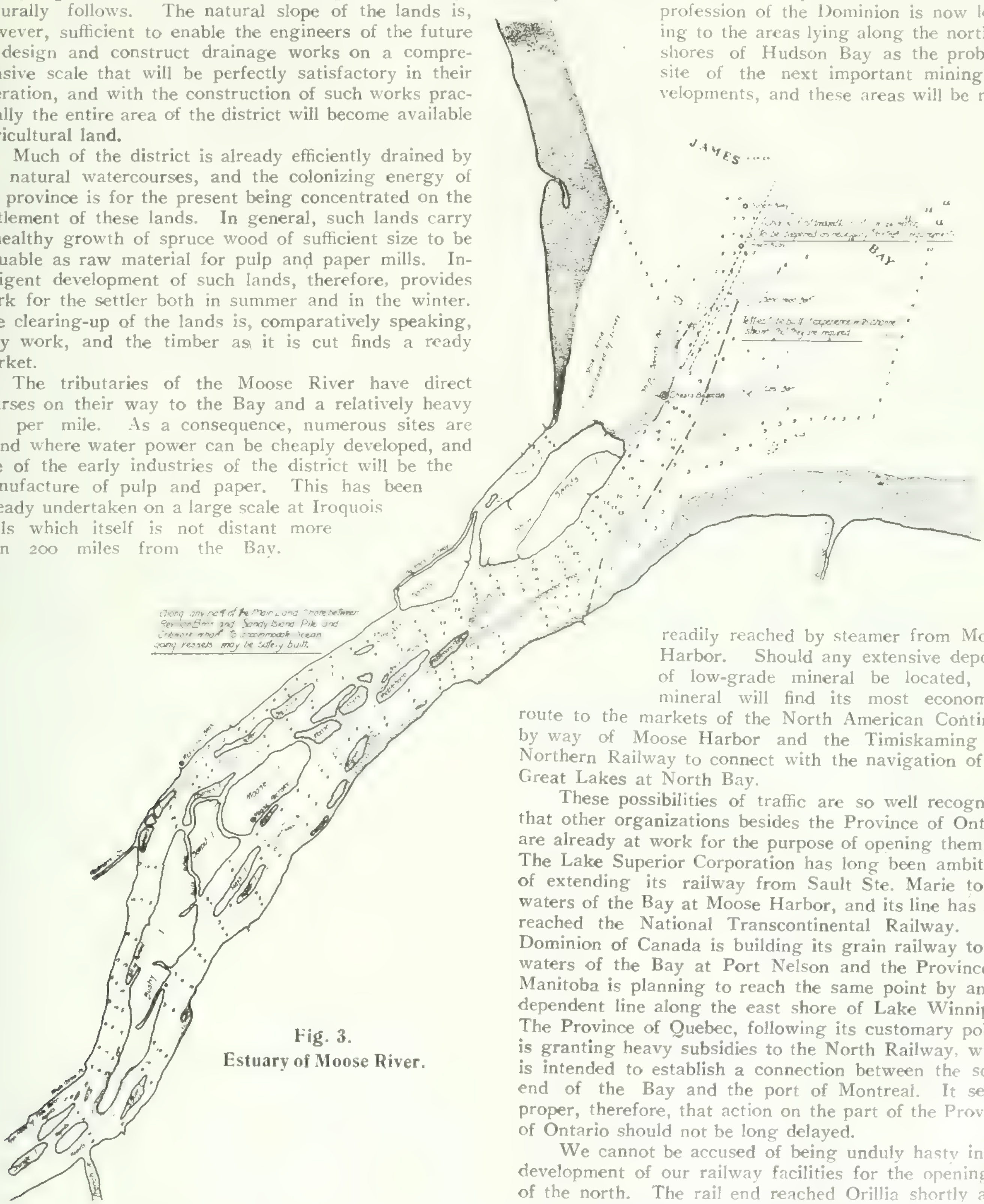

Fig. 3.
Estuary of Moose River.

In this development the opening of a port on the Bay must play a considerable part, providing a route by which such necessary materials as coal can be brought in without excessive freight charges and such low-grade materials as groundwood pulp can be exported, freight charges being perhaps the most important item in the market cost of the last-named product.

The district north of the height of land is so completely overlaid with clay that there is there little probability of further mineral development, but the mining profession of the Dominion is now looking to the areas lying along the northern shores of Hudson Bay as the probable site of the next important mining developments, and these areas will be most readily reached by steamer from Moose Harbor. Should any extensive deposits of low-grade mineral be located, this mineral will find its most economical route to the markets of the North American Continent by way of Moose Harbor and the Timiskaming and Northern Railway to connect with the navigation of the Great Lakes at North Bay.

These possibilities of traffic are so well recognized that other organizations besides the Province of Ontario are already at work for the purpose of opening them up. The Lake Superior Corporation has long been ambitious of extending its railway from Sault Ste. Marie to the waters of the Bay at Moose Harbor, and its line has now reached the National Transcontinental Railway. The Dominion of Canada is building its grain railway to the waters of the Bay at Port Nelson and the Province of Manitoba is planning to reach the same point by an independent line along the east shore of Lake Winnipeg. The Province of Quebec, following its customary policy, is granting heavy subsidies to the North Railway, which is intended to establish a connection between the south end of the Bay and the port of Montreal. It seems proper, therefore, that action on the part of the Province of Ontario should not be long delayed.

We cannot be accused of being unduly hasty in the development of our railway facilities for the opening-up of the north. The rail end reached Orillia shortly after 1870, it reached North Bay about 1886, and was continued from North Bay to Liskeard between 1900 and 1905, and on to Cochrane about 1910, an average movement northward of perhaps 10 miles per year.

Historically, Moose Harbor, under the name of Moose Factory, is an old and long-settled port, from

which the business of the surrounding country has been handled for nearly 250 years. Generations of people have lived and died there, and the suitability of the site as a point of permanent residence is beyond question. It is interesting to note that one of the earliest experiences of this settlement was its complete destruction in a time of peace by a marauding, overland expedition sent out from Montreal—apparently with the definite intention of maintaining the supremacy of that city as the centre of the fur trade. In fact, the commercial possibilities of the Bay received more attention between the years 1670 and 1700 than they have at any other time up to the present.

Moose Harbor provides a magnificent site for the creation of a great port. The estuary, shown in Fig. 3, is perhaps 20 miles long and varies from 1½ to 3 miles wide. It is crowded with islands, and through the intervening channels there discharges the great river which is never, so far as we know, smaller than the Ottawa River has been since the government has regulated the flow of that stream by its storage works. The settlements and fields on the islands give evidence of long occupation, and the flat-lying shores provide an ideal site for a rail and water terminal.

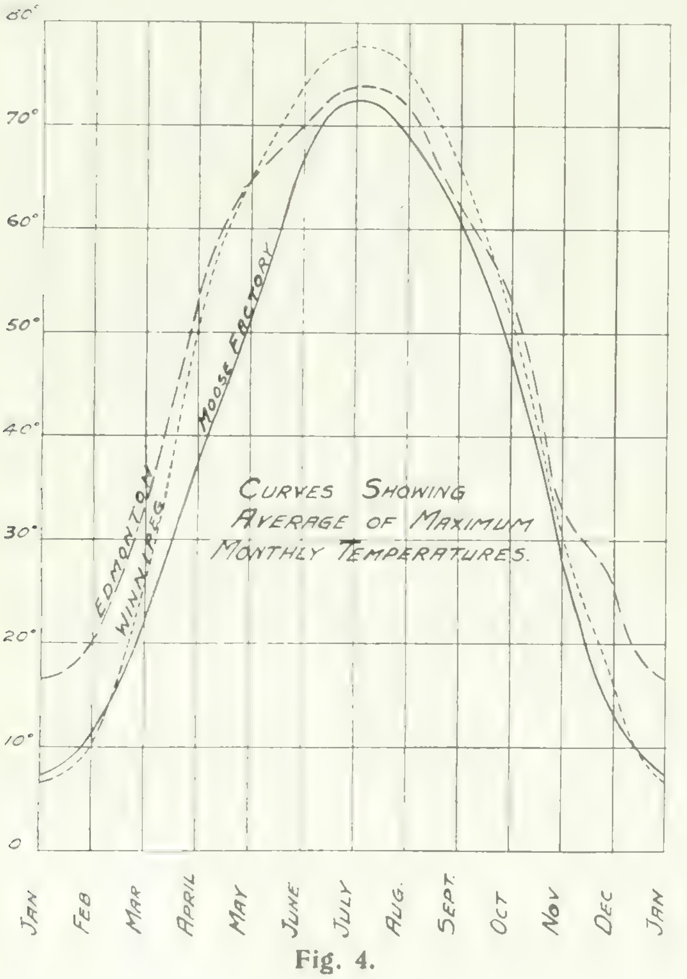

Fig. 4.

Up to the time that the commission issued its orders that the possibilities of this site were to be investigated there was a general impression that the construction of an ocean terminal at the south end of the Bay was for all practical purposes an impossibility, and that the shallow and rocky shores presented an obstacle that could not be overcome within the limits of reasonable cost. The first definite information concerning the locality was obtained by survey parties sent out in 1911, which made a complete instrumental survey of the estuary during that season. The natural conditions, as shown by the plans prepared from these surveys, were so advantageous that further instructions were given by the commission to continue the investigations and to ascertain fully facts concerning all natural conditions, both favorable and unfavorable.

Temperatures had long been under observation at the posts of the fur-trading companies and a study of the results of these observations showed that the Harbor had a winter temperature closely corresponding to that of Winnipeg. In summer and fall its temperature corresponds to that of Edmonton, but the spring is backward and most nearly corresponds to that of Cape Breton. The corresponding maximum, mean and minimum temperatures of Edmonton, Winnipeg and Moose Factory respectively are illustrated in Figs. 4, 5 and 6. Any Canadian, therefore, who knows his own country will encounter no new conditions of temperature if he is called upon to take up his residence in Moose Harbor.

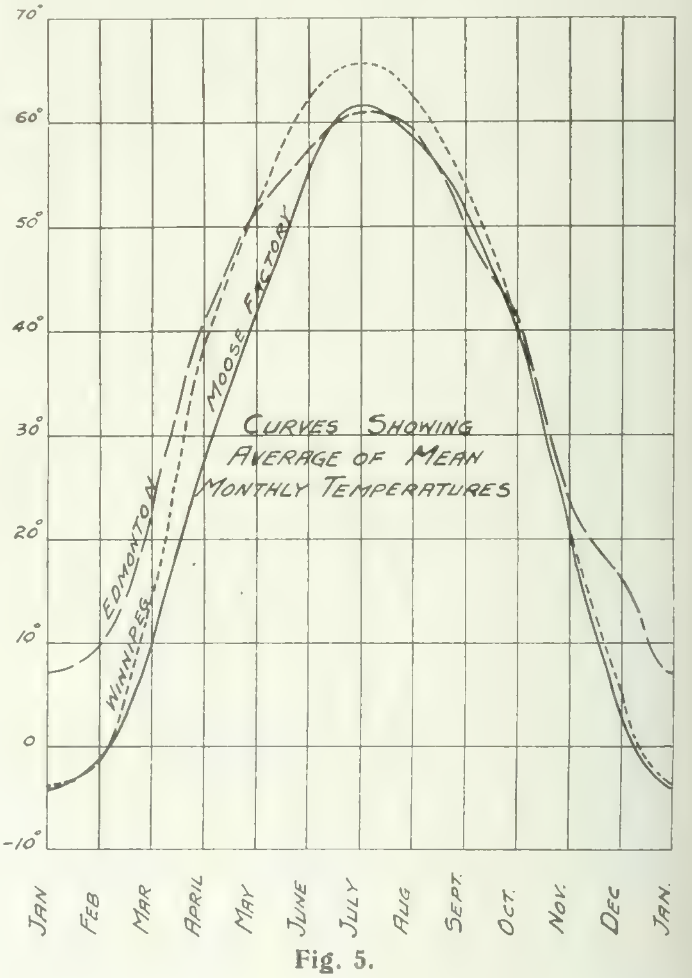

Fig. 5.

Observations have been made upon the tides in the estuary, and these are found to be of very moderate dimension, the range rarely exceeding 6 ft. and often being as low as 2 ft. In this respect, Moose Harbor compares very favorably with its rivals, Port Nelson and Rupert House, the extreme range of the one being given as 18 ft., and of the other as 12 ft.

Measurements have been made of the currents in the estuary created by the tides, and the maximum velocity of these currents, under ordinary conditions, has been found to be about 4½ lin. ft. per second, or, roughly, 2½ knots per hour. Such velocities will not in any way

interfere with the movement of modern steamship traffic. Higher velocities than those which have been determined by the observations will exist during the periods of the discharge of the spring floods, but as a general rule these floods will have passed by before the active traffic of the port commences for the year. Fig. 7 is a chart of tide velocities from the report of J. G. McMillan on the Moose River.

The surveys of 1911 showed that in the neighborhood of the fur-trading posts the river was divided into two great channels, and that the depth of water in these channels varied to such an extent that their improvement would be expensive.

Below the posts the two channels united into one broad and deep waterway, bordered by very extensive sand bars. The depth of water in the main channel varies at low tide from 15 to 20 ft., but this fairway is cut off from the main Bay by a bar having a total width of, roughly, 4 miles and a minimum depth of water at low tide of about 6 ft. Beyond the bar the depth of water steadily increases until at a short distance out soundings are secured that are satisfactory for any probable navigation.

The studies of the site have not yet been completed up to such a point that the engineers can give a very positive opinion concerning the method of formation of this bar. The bar itself constitutes the most formidable existing obstacle to the development of the port, and the method to be adopted for its removal will depend largely upon the cause of its formation. Similar bars have been formed in other rivers, sometimes out of the silt carried down by the river itself, and sometimes from silt carried by the littoral currents. It is questionable whether either of these methods of formation has been active at the mouth of the Moose River.

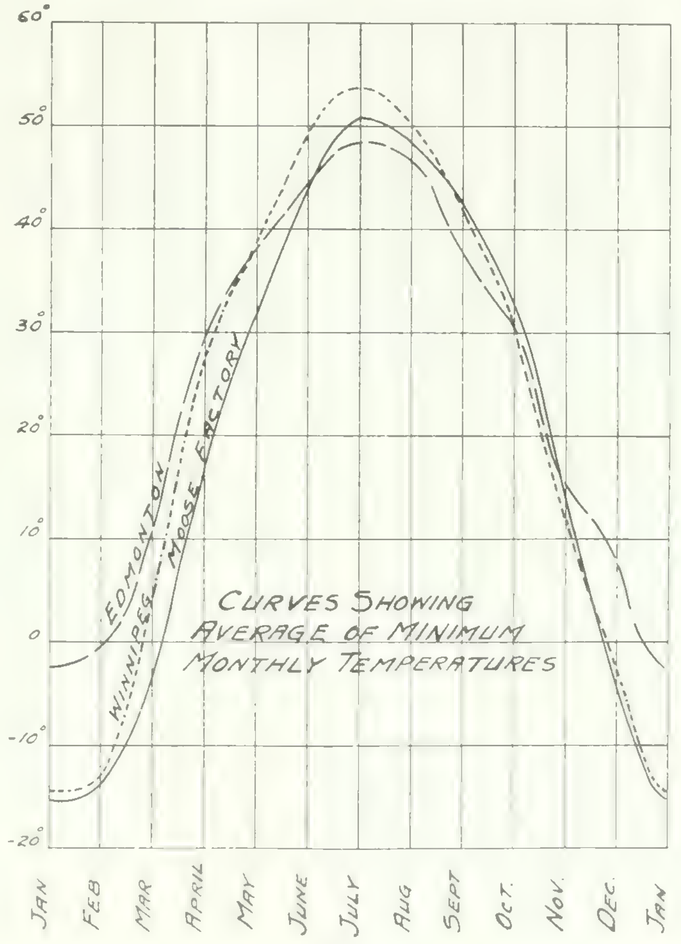

Fig. 6.

No effort has as yet been made to determine the direction and force of the littoral currents, but owing to the shallowness of the coast waters and to the exposed situation of the coastline strong and variable currents of this nature are certain to be found from time to time. Owing to the nature of the material along the shores, it is not believed that these currents will carry any large amount of silt with them, or that they have contributed materially to the existence of the river bar.

Efforts have been made to determine the quantity of silt carried down by the river itself; but although the waters at their ordinary stage are often discolored the material in suspension is so light that it is almost impossible to secure a deposit from a sample taken out of the river and it is probable that for at least nine months in the year the river carries with it no material that would be a factor in bar building. At the time of the annual break-up the shores and bed of the river are badly eroded by the ice-shoves and large quantities of earth and similar material are carried down into the estuary. During the early summer such deposits of material are distributed by the action of the tides and currents. In view of the fact that the spring discharge of the Moose River is very heavy and that the maximum currents will be found in the deepest channels, it is believed that there will be no appreciable deposit of silt in any channel which may be cut across the bar. There is evidence that the flood discharge of the river is as high as 400,000 second-feet, but this figure is not considered to be well established.

The theory held at present by the engineers is that the river channels have been cut through the clay bed of the Coastal Plain in an almost haphazard fashion by the waters of the river itself, and that the bar at the mouth simply consists of the material of the original bed of the Bay, no channel having been cut at this point because the velocity of the river water has been checked by its impact against the waters of the Bay. This theory can be partly confirmed by borings to determine the quality of the material in the bar, and the making of such borings was planned for the spring of 1913. In that year the ice went out of the river at an unexpectedly early date and the survey parties had to flee for their lives and were forced to abandon their equipments to the mercies of the ice-shoves. It is purposed to make good this deficiency in data during the present summer.

A number of borings have been made along the estuary and in each case the material found has been a material which can be readily and cheaply removed by dredging. Solid rock has been noted along the coast line some miles to the east and some miles to the west of the estuary, but not in its immediate vicinity. The borings also give some indication of solid rock in the bed of the river some miles above the fur-trading posts, but no such indications have been found in that portion of the river which it is proposed to improve.

Some time has been devoted to the study of such typical cases of bar formation as Toronto Island and as the Passes of the Mississippi River, but the underlying causes in these cases are forces which apparently are not at work to an appreciable extent in the estuary of the Moose River. The engineering precedents which have been established in dealing with natural difficulties similar to those just referred to will, none the less, be of great

value in determining the final lay-out for the development of Moose Harbor. Perhaps the most valuable of them is the now recognized persistence of a river in maintaining its banks and channels unaltered, even when these are built up of most easily eroded materials.

The depth that will be required in the channel at low water will naturally increase as the traffic increases. It is not believed that traffic conditions will justify the construction of a channel of more than 15 ft. depth at low water at first, and the excavation of a 300-ft. channel of this depth out to the Bay should cost in the neighborhood of $600,000. Heretofore all work of this nature in Canada has been carried out by the Department of Public Works and the estimate given above is based on the average cost of the dredging that has been done by that department. If precedent is followed, the cost of executing this portion of the development will fall upon the Dominion of Canada and not upon the Province of Ontario or the Timiskaming and Northern Ontario Railway.

At the post of the Hudson Bay Company an extended, but not wholly systematic, series of observations has been kept of the dates upon which the river has been closed by ice and of the dates of the annual spring break-up. Comparison between this record and a similar record for the port of Montreal has been made and shows, in Fig. 8, that the open season for the port of Montreal is more than a month longer than the similar season at Moose Harbor. The open season at Moose Harbor will have a duration of from 5½ to 6 months, and, should the traffic warrant the expense, it could be readily extended at both ends by the use of ice-breakers. In one respect the comparison above referred to is not fair to Moose Harbor in that it overlooks the fact that Moose Harbor is directly on tide water and is open to the sea as soon as the ice goes out. This is not true in the case of Montreal, where the river between Quebec and Montreal is not infrequently blocked by ice after the harbor of Montreal is itself clear. In the case of Moose Harbor, the action of the river waters in sweeping clear the harbor and the bay immediately in front of the estuary was one of the principal reasons for selecting a river terminal in place of a harbor constructed out into the bay itself.

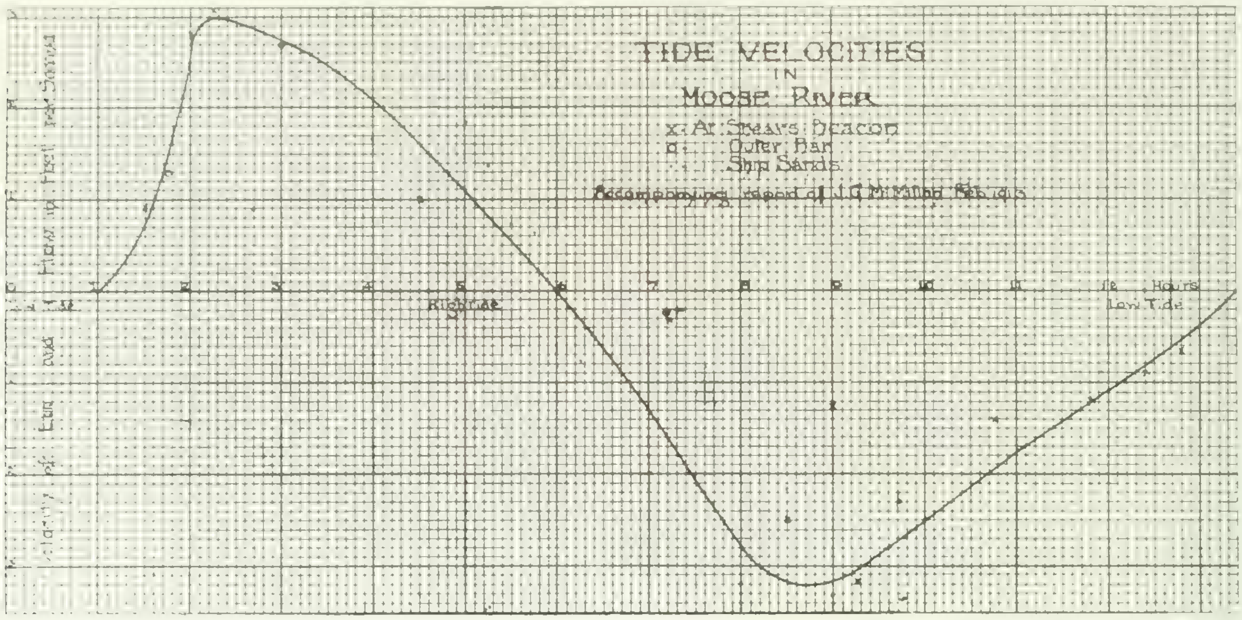

Fig. 7.

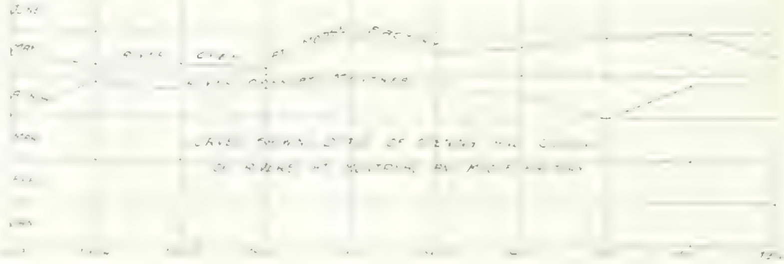

Fig. 8.

An examination of the winter ice cap over the estuary has shown that this cap consists of a fairly uniform sheet of about 3 ft. in thickness and that there is little drift ice or bordage under the main ice cap. Examination has also been made to determine whether frazil ice existed in quantity in the channels of the estuary, as it is usually found to exist in the lakes and pools of the St. Lawrence watershed. It was expected that, owing to the winter cold and to the rapid and turbulent course of Moose River, large quantities of this frazil ice would be found to be present as it was well-known from the labors of the Montreal Flood Commission of 1888 that such ice constituted one of the principal causes of the great spring floods in the harbor of Montreal. No explanation has as yet been advanced for the absence of

frazil ice from the Moose estuary, but this absence certainly removes from the undertaking one of the most serious difficulties that has to be overcome by Canadian hydraulic engineers.

Enquiry at the Hudson Bay post revealed the fact that only on rare occasions does the ice move quietly out of the harbor. As a general thing, the ice cap remains solid and undisturbed until it is shattered to pieces by a rush of water and float ice from the upper and more southerly portions of the river, and heavy shoves almost invariably accompany the clearing of the harbor. So far as spring conditions are concerned there is, indeed, a very close resemblance between Moose Harbor and Montreal. In each case there is a river of great width with many shallow areas, with obstructions in the form of islands, and with low-lying shores. The channels are blocked with ice and the clearing forces are the spring waters which, in the two cases, are not far from equal in quantity. The St. Lawrence River is a much greater stream than the Moose, but its flow throughout the year is also much better regulated, and as a consequence there is not on the St. Lawrence the great difference between the spring and fall discharge that exists in the case of the Moose River. The movements of the ice in the Moose estuary, as described by the officials of the Hudson Bay Company and by the observers sent out by the commission, are very similar to the well-known movements of the ice in Montreal harbor, and the construction methods that have long been followed with success in Montreal harbor may, with safety, be adopted by the engineers of the commission.

For possibly 100 years, wharf construction in Montreal took the form of heavy timber cribs built roughly parallel to the original shore of the river and to a height of 10 or 12 ft. above normal summer water. All sheds and handling apparatus were removed from the wharves every autumn, and invariably in the spring the flood waters rose until they were deep over the wharf sites. As the moving ice was lifted by the waters the force of the shoves was rarely found to have expanded itself upon the wharves themselves, although occasionally portions of the upper part of the wharves were completely torn away. The extent of such damage has been proved to be slight and it was always readily repaired from year to year. There is no evidence to show that the ice-shoves in Moose Harbor are as great or greater than some of the shoves that have been observed in recent years at Montreal, and it is believed that in the earlier years of its development no better plans can be made for Moose Harbor than those which have worked successfully for so long in Montreal.

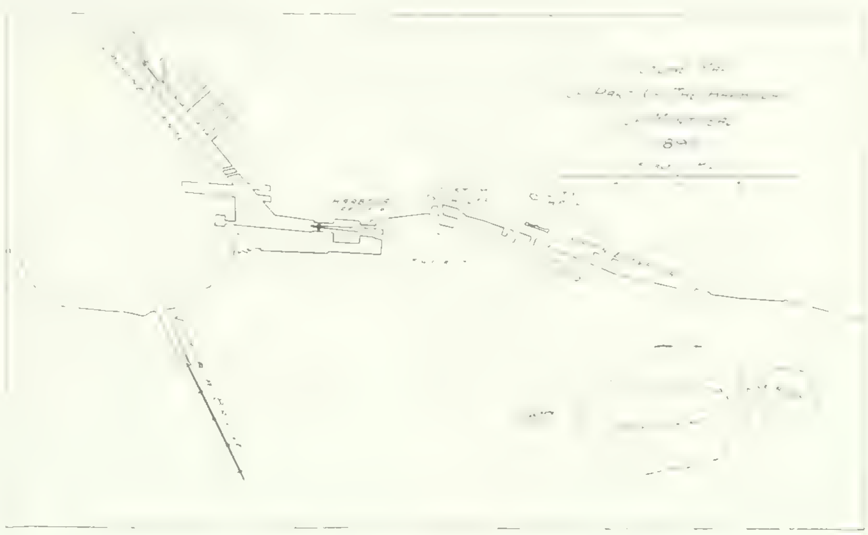

Fig. 9.

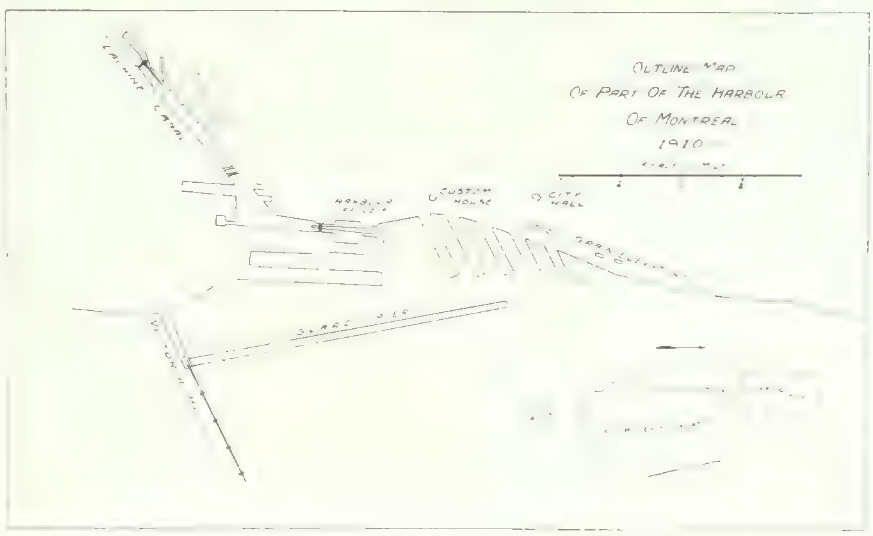

Fig. 10.

There is an excellent site on the north shore of the estuary, extending from the post of Révillon Frères to the head of Sandy Island, for a development on the Montreal principle. The channel in front of this shore is of satisfactory depth, and the lands behind it have the proper contour for an efficient railway yard. The cost of 1,000 ft. of crib wharfing may be estimated at approximately $150,000.

How often this wharf will be overflown in spring it is impossible to say, as the rise of the waters in the estuary, which reaches a maximum of 20 ft., is caused entirely by the ice-shoves and the location of these shoves is very variable from year to year. Sometimes the force of the break-up is expended as far as 15 miles above the bar, while at other times the shoving, jamming and flooding may continue to within three or four miles of the bar itself. In the spring of 1913 the final ice-shoves occurred at a point unprecedentedly low in the estuary, and the waters overflowed areas on which the engineers had, in a preliminary way, projected terminal works which were believed to be safe from flood.

Considering again the history of the port of Montreal, Fig. 9 shows a map of the port some 20 years ago, before it was decided that the traffic had grown to be of such importance that it could not be satisfactorily handled with terminal facilities that had to be removed out of the way of the action of the ice every year, and the present main harbor of Montreal was then designed, two principal

problems to be solved being protection from flooding and protection from the destructive force of the great ice-shoves which had been known to pile ice to the depth of 60 ft. upon the then existing wharves. The latter difficulty has been met by constructing across the face of the harbor and parallel to the main thread of the river an enormous earth bank known as the Guard Pier. The material for this pier was obtained from the bed of the river in enlarging and deepening the harbor, and it is built to such height that no ice-shove has passed over it and by reason of its material and shape it is practically invulnerable so far as damage from ice action is concerned. Behind the protection of this pier the present concrete and timber wharves of Montreal were built and to an elevation which protects them from flooding except under the most extreme conditions, and on these wharves have been built the permanent sheds and other equipment which now constitute the handling arrangements of the port of Montreal.

It is noteworthy that the engineer for the Montreal Harbor Commission, Mr. John Kennedy, M.Can.Soc. C.E., was so fully satisfied of the soundness of his plan of guard pier construction, shown in Fig. 10, that he did not hesitate to place the entire fleet of the commission in the river, but behind the guard pier, during the first winter following the completion of its construction, and the very slight movements of the ice which have since occurred behind the guard pier are satisfactory proof of the soundness of the principles followed in its design.

In Moose Harbor there is an excellent site at Sandy Island which can be readily converted into a protective harbor of the Montreal type whenever the traffic of the port has grown to such magnitude that it will justify the expenditure involved in such construction, and there appears to be no reason why this site should not be indefinitely reserved for the purpose.

It is not the view of the engineers of the commission that their work at Moose Harbor is yet so complete that the outlines of development, as now contemplated, will not be altered. It is proposed during the present year to determine the character of the material in the bar and to make a special study of the movements of the currents in the estuary. Attention will be given to the question of training walls in the neighborhood of the bar similar to those so successfully constructed by Captain Eads at the mouth of the Mississippi River, although, as already indicated, the judgment of the engineers is that the natural conditions in Moose Harbor do not call for the adoption of Mississippi methods.

As a conclusion, it may be said that the work which has been done up to date has proved beyond question that the construction of a deep-water terminal at Moose Harbor is perfectly feasible, and that it does not involve more than a very moderate expenditure. It may also be said that no problem will arise in the construction of the harbor works which has not already been successfully dealt with elsewhere, and that the exploratory surveys for the railway extension from the present terminus at Cochrane to the Harbor are so well advanced that this portion of the undertaking is known to be a piece of railway construction of the most ordinary type.

A [illegible]-mile concrete boulevard along the shore of Lake Michigan, from Chicago to Milwaukee, is being planned.

An announcement was made at the Maritime Motor Show in St. John, N.B., to the effect that the Dominion Motor Car Company will erect a factory at Coldbrook, N.B., [illegible] miles from St. John, to assemble and manufacture sections of [illegible] cars which will be placed on the Canadian market.

TAR FORMING TEMPERATURES OF AMERICAN COALS.

The University of Wisconsin has just issued a bulletin prepared by O. C. Berry, under the direction of Prof. A. G. Christie, on the characteristics of the volatile matter in bituminous coal. The bulletin covers a series of investigations to determine the temperature limits between which tars are distilled from various classes of coal; the temperature limits of the maximum rate of evolution of tars, and the relative quantities of tars distilled from various general classes of coal. The object of the research centres around the important part which volatile matter plays in determining how the coal must be handled in order to obtain the best results considering the enormous annual consumption of coal of various kinds. Tar, being one of the most important and troublesome constituents, especially where coal must be used in boiler furnaces or in producer plants, are the subject of a thorough examination along the above lines.

The bulletin gives a thorough discussion of coal and its characteristics and also of the problems related to the question of tar and combustion. This is followed by an explanation of the test conditions as compared with actual operating conditions and a record of the tests. The conclusions arrived at are as follows:

(1) Tars first commence to distil from any grade of bituminous or lignite coals at about 300 degrees C.

(2) The greatest quantity of tars are distilled between the temperatures of 375 degrees C. as an average lower limit and about 475 degrees C. as the final temperature.

(3) The tars have all been evolved on the average when the coal reaches a temperature of 550 degrees C., though in some cases tar did not cease to appear till the temperature reached 600 degrees C.

(4) The temperatures at which the tars distil are not dependent on either:

(*a*) the geological age of the coal,
(*b*) the amount of volatile matter in the coal,
(*c*) the ratio of carbon to hydrogen in the class of coal tested.

In other words, tars may be expected to appear or disappear at approximately the temperatures given above with any grade of American bituminous coal.

(5) There is no evident relation between the amount of tar evolved and the amount of volatile matter in coal.

(6) There is evidently a distinct relation between the amount of tar distilled and the geological formation of the coal, or, more particularly, the carbon-hydrogen ratio of the coal. The maximum amounts of thick tars can be expected from coals with carbon-hydrogen ratios ranging from about 13.5 to 18. It is also possible, knowing the carbon-hydrogen ratio of any given coal, to predict with considerable accuracy the probable amount of tar that will be distilled as compared with some other known coal.

(7) There are added reasons for believing that the volatile matter of western coals contain fixed gases and watery vapors of low heating value if not entirely non-combustible. This is shown by the small amounts of tar deposited and by the low heating value when calculated on the "unit coal" basis.

The Northern Electric Company, of Montreal, has recently closed a contract whereby it will establish in Regina its general headquarters for the west.

BOUNDARY WATERS OF RAINY RIVER DISTRICT.

THE negotiations between Canada and the United States relative to the water level of Lake of the Woods, and which have been under way for some time, formed the subject of a progress report dated January 16th, 1914, to the various governments by the International Joint Commission, to whom the matter was referred.

The collection of information has involved an immense amount of difficult field work, including flood damage surveys on the shores of the lake, storage surveys of the lakes in the vicinity of the international boundary tributary to the Rainy River and reconnaissance surveys of the secondary storage basins lying wholly within the boundaries of either country. The work was carried on under the supervision of Mr. A. V. White, of Toronto, and Mr. A. F. Meyer, of St. Paul, consulting engineers of the commission, by field parties appointed by both countries.

The following questions were submitted to the commissioners by the Canadian and United States governments:—

(1) In order to secure the most advantageous use of the waters of the Lake of the Woods and of the waters flowing into and from that lake on each side of the boundary for domestic and sanitary purposes, for navigation and transportation purposes, and for fishing purposes, and for power and irrigation purposes, and also in order to secure the most advantageous use of the shores and harbors of the lake and of the waters flowing into and from the lake, is it practicable and desirable to maintain the surface of the lake during the different seasons of the year at a certain stated level; and if so, at what level?

(2) If a certain stated level is recommended in answer to question No. 1, and if such level is higher than the normal or natural level of the lake, to what extent, if at all, would the lake, when maintained at such level, overflow the lowlands upon its southern border, or elsewhere on its border, and what is the value of the lands which would be submerged?

(3) In what way or manner, including the construction and operations of dams or other works at the outlets and inlets of the lake or in the waters which are directly or indirectly tributary to the lake or otherwise, is it possible and advisable to regulate the volume, use, and outflow of the waters of the lake so as to maintain the level recommended in answer to question No. 1, and by what means or arrangement can the proper construction and operation of regulating works, or a system or method of regulation, be best secured and maintained in order to insure the adequate protection and development of all the interests involved on both sides of the boundary, with the least possible damage to all rights and interests, both public and private, which may be effected by maintaining the proposed level?

During the winter months of 1912-13 the consulting engineers devoted their attention to the gathering of data from various governmental and other sources on both sides of the boundary. They also made a personal reconnaissance of portions of the Lake of the Woods watershed in order to ascertain the extent and character of the field work necessary to determine the best means by which regulation might be secured and also to determine the possible effect that certain schemes of regulation might have upon the various interests using the waters of the Lake of the Woods and the shores and harbors thereof.

During the winter the engineers also completed their plans for work in the field, and in the spring as soon as conditions would permit survey parties were gathering the essential data. This field work was prosecuted throughout the summer and autumn of 1913. The care with which the work was distributed and the energy with which it has been pushed forward has resulted in very substantial and gratifying progress in the gathering of important information upon some of which the commission will no doubt base its final report to the two governments.

While the investigation is still incomplete and all figures must be subject to revision, it is stated in the progress report that the watershed involved in the investigation—that is, the combined area of land and water surface above the outlet of the Lake of the Woods—is approximately 26,000 square miles, of which about 15,000 square miles are in Canada and 11,000 square miles in the United States. This area forms part of the Hudson Bay watershed, which finds its principal outlet through the Nelson River. Into the character and extent of the main watershed below the mouth of the Winnipeg River, it is unnecessary to inquire, so far as the present investigation is concerned, but it is important to have some general knowledge of the waters which join the Winnipeg River from the northwest, and which go to swell the volume contributed to that river by the Lake of the Woods and its tributaries. It is estimated that the English River and other affluents of the Winnipeg River below the outlet of the Lake of the Woods drain an area of about 29,000 square miles.

The intricate system of waterways which finds its outlet in the Lake of the Woods through Rainy River extends on the one side into northern Minnesota and on the other into western Ontario. This area above the mouth of Rainy River is approximately 20,000 square miles. That portion of it above the outlet of Rainy Lake is about 14,500 square miles. The Lake of the Woods itself contains an area of 1,400 square miles; Rainy Lake, 325 square miles; and there are also within the watershed some 36 lakes ranging in area from 10 to a hundred square miles, besides a large number of smaller bodies of water.

One of the results of the hearings was to bring out not only the variety and magnitude of the resources of the Lake of the Woods region, but also the importance of the interests involved in the development of these resources on both sides of the boundary. Not less than $100,000,000 have already been invested in this important district, including the lumber industry, pulp and paper mills, power plants, flour mills, fisheries, etc. The lumber mills are situated at various points on the Rainy River and the north shore of the Lake of the Woods, the valuable timber limits which supply them covering thousands of square miles in Ontario and Minnesota. Large pulp and paper mills are situated at International Falls, Minn., and Fort Frances, Ontario, and flour mills at Kenora, Ontario, on the north shore of the Lake of the Woods. Large power plants, representing an investment of many millions of dollars, are found at International Falls in connection with the pulp and paper industry, at Kenora for the operation of flour and other mills, and on Winnipeg River for the purpose of supplying light, heat, and power to the city of Winnipeg and operating the Winnipeg street railway. The towns of International Falls, Fort Frances, and Kenora are also lighted by the power plants in their vicinity.

Navigation has been maintained more or less on the Lake of the Woods and Rainy River for over 30 years by steam craft engaged in freight and passenger service, lumbering, and the fisheries. The navigation interests complained that their operations were interfered with by low water in Rainy River, caused by the operation of the power works at International Falls and Fort Frances.

The Canadian government has shown its interests in the navigation of these waters by subsidizing a line of steamers between Fort Frances and Kenora, by extensive dredging at the mouth of Rainy River, and by the provision of lights and other aids to navigation. The United States government has also carried out dredging at Warroad and elsewhere on the south shore of Lake of the Woods. Some years ago a sum of money was voted by the Canadian Parliament for improving the navigation of Rainy River at the Long Sault Rapids by means of a dam and lock. Difficulties arose owing to the international character of the stream, and in 1911 a private corporation, the Western Canal Company, was incorporated having the same object in view. Nothing, however, has yet been accomplished.

Many years ago the Canadian government built a canal on the Canadian side of the river at International Falls. This canal is now closed at the upper end by the waste gates of the power dam, but the Canadian government has reserved the right to re-open the canal whenever it may be required for navigation purposes. In the plans of the power company the United States government also ordered provision for a canal on the American side, should it be found necessary at any future time. In connection with these existing or projected locks at International Falls and the Long Sault Rapids, mention may be made of a larger project, which has been mooted in Canada, for creating a navigable waterway by means of a series of locks and dams and the improvement of existing waterways between Lake Superior and Lake Winnipeg.

A large portion of the country surrounding the Lake of the Woods and its tributaries is not of a nature suitable to agriculture, but farming is being carried on along the banks of Rainy River; on the south shore of the Lake of the Woods, where there is much valuable agricultural land, in the neighborhood of the North West Angle, on the eastern shore of the lake north of Rainy River, and on some of the islands. Complaints have been made that some of these lands, which are low lying, have been flooded by reason of the maintenance of the Lake of the Woods above its natural level by the operation of dams at the outlet of the lake, which dams are wholly in Canadian territory.

The fisheries of the Lake of the Woods are both extensive and valuable. Over 1,500,000 pounds of fish were shipped from these waters in 1912. Statements were made at the hearings to the effect that changes of level in the lake were detrimental to the fisheries, as the lowering of the water injures the spawning grounds.

Some evidence was obtained at the hearings at International Falls, Warroad, and Kenora as to sanitation and the pollution of waterways. Complaints have since been received as to the pollution of the waters of Rainy River by sewage disposal and by the dumping of refuse from the pulp and paper mills at International Falls.

The hearings held by the commission in September, 1912, indicated in a general way the requirements of the various interests concerned in the levels of Lake of the Woods:

(1) Navigation, requiring a high summer level of the lake.

(2) Agriculture, immediately along the shore of the Lake of the Woods, requiring a fixed maximum level, which will obviate undue flooding and make available the greatest area along the shore for agricultural purposes.

(3) Industries, broadly divided into: (*a*) Manufacturing interests, requiring a more or less uniform flow throughout the year. (*b*) Municipal plants for light, heat and power, requiring a regulated flow, which varies with the seasons, the winter loads being heavier and necessitating an increased flow.

(4) Fishing, requiring a fairly uniform lake level, otherwise considerable fluctuations will expose reefs and destroy fish spawn.

Difficulties in Regulating Lake Levels.—The harmonizing of these interests, which under the extremes of demand are conflicting, makes the problem of the regulation of lake levels somewhat difficult. The regulation of the levels of the Lake of the Woods, having in view not only present but prospective needs, depends upon the regulation of the inflow as well as that of the outflow. It therefore involves two classes of controlling works:

(*a*) Primary works, to be located in boundary waters at the outlets from the Lake of the Woods.

(*b*) Secondary works, to be located in each country, to regulate the run-off into the boundary waters which supply that lake.

In view of the entire drainage area involved, about 26,000 square miles, being largely wooded, these secondary controlling works, necessary in a measure to-day, will become imperative in the future. And the vast interests depending on the timber supply in this great watershed must be concerned in the upkeep of that supply, so closely related to the conservation of the water resources of the district.

The field work in connection with the investigation has been divided into several more or less distinct sections:

(1) Detail and reconnaissance surveys of the shores of the Lake of the Woods, Rainy Lake, Namakan, Kabetogama, Sand Point, Crane, and a number of other lakes.

(2) Topographic and other data relating to outlets of Lake of the Woods.

(3) Stream flow records and meteorological data throughout the drainage area.

Extent and Necessity of Surveys.—The surveys in connection with the Lake of the Woods fall naturally into two classes. So far as the south shore of the lake is concerned, and certain areas on the east and west shores, where the lands are low lying, detail surveys are being made to show the effect on these lands—particularly those susceptible of cultivation—of various levels of the lake. The north shore, on the other hand, is generally more elevated, and a comparatively rapid reconnaissance survey was considered sufficient to obtain the data needed in connection with the investigation.

Between the months of June and October, 1913, a party of engineers made a detailed topographic and hydrographic survey of the lowlands along the southern border of the Lake of the Woods, from a point in Manitoba two miles north of the international boundary, south and east through Minnesota, and north again into Ontario, to a point about three miles northeast of the mouth of Rainy River. This survey covered about 70 square miles of actual area, and has been carried out in a manner to enable the commissioners to answer to what extent, if at all, would the lake, when maintained at such level, overflow the lowlands upon its southern border.

The field work elsewhere on the Lake of the Woods, comparable in character to that already done on the south shore, will cover certain areas on the easterly shore of the lake from near the mouth of Rainy River up to and including portions of the Big Grassy River, also on the west shore from about the international boundary northward to North West Angle Inlet. It is proposed to place the engineers in the field as early as practicable this spring and conclude the surveys before the early fall of 1914.

In carrying out the reconnaissance survey of the northern portion of the Lake of the Woods, including the principal islands and the shores of Shoal Lake, work was commenced in September, 1913, at Kenora and carried along the north and east shores of the lake to the mouth of Miles Bay. The entire shore line of the Lake of the Woods, including the principal islands and Shoal Lake, has now been examined, with the exception of the comparatively small areas on the east and west shores already referred to.

As Rainy Lake is the most important secondary storage reservoir in the Lake of the Woods watershed, and the level of the lake is controlled by the dam at International Falls, it was considered necessary to ascertain to what extent it could be utilized for storage purposes, and what the effect of certain levels would be on the surrounding lands, timber, etc. This survey has been completed, and the results are now being plotted, collated, and analyzed in the office.

It being thought desirable to have an examination made of some of the larger secondary storage reservoirs above Rainy Lake and lying wholly within the Province of Ontario, arrangements were made with the hydrographic branch of the Hydro-Electric Power Commission of Ontario to carry out the work.

These surveys were carried out in the summer of 1913, and included an examination of Upper and Lower Manitou Lakes, Otukemamoan Lake, White Otter Lake, Clearwater Lake, and Lac des Milles Lacs. As a result of this reconnaissance the following opinions have been advanced:

(1) That in all cases it would be physically possible to construct storage works of sufficient extent to entirely control the run-off of the watersheds above the outlets of the various lakes.

(2) That works of sufficient extent to control the run-off above the outlet of Lac des Milles Lacs would add considerably to the area of the lake due to the drawing out of large tracts of muskeg, and that some damage would be caused by backwater in the village of Savarne.

(3) In the case of all the other wakes examined the entire run-off of their respective watersheds could be controlled by comparatively inexpensive works without damaging timber of any value and without material increase in lake area.

(4) That dams have at one time or another existed at the outlets of all the above lakes, and timber dams in good condition now exist at the outlets of Manitou, White Otter, and Clearwater Lakes.

Arrangements have been made with the Public Works Department of Canada for certain surveys in the vicinity of the Long Sault Rapids, at the lower end of Rainy River, but as it was not found possible for the department engineers to complete this work during the season of 1913 a small survey party was detailed by the consulting engineers to make a preliminary survey.

During the summer of 1913 surveys above Kettle Falls were resumed and embraced the north shore of Namakan Lake.

During 1913 a number of men of the Manitoba hydrographic survey of the Canadian Department of the Interior have been engaged in collecting hydrographic data and in making surveys of the various outlets of the Lake of the Woods in the vicinity of Kenora and Keewatin.

In addition to the general field work, consisting of detail and reconnaissance surveys, water gauges, established by departments of both governments, and the commission were being read once, twice, or three times daily at various points on the Lake of the Woods watershed. Current meter gaugings were made almost daily at the various outlets of the Lake of the Woods, and frequent meter gaugings were also made of various tributary waters. Complete meteorological records, embracing temperature, humidity, rainfall, evaporation, and wind velocity were kept daily during the season.

Although only a little more than a year has elapsed since the investigation was begun, the commission in that time covered by surveys and reconnaisance a large portion of the drainage area of about 26,000 square miles, and has also collected a vast amount of necessary and important engineering data and obtained much other necessary information concerning the interests of the people in both countries to be affected by the final conclusions and recommendations of the commission. The data and information thus far obtained is being tabulated and put in proper and convenient form and from which maps are being prepared for the use of the commission in forming and illustrating its conclusions on which final recommendations to the United States and Canada can be based.

The waters involved in this investigation mark the boundary between two great countries for a distance of almost 500 miles. These waters are the common property of the United States and Canada. The right to their use is a right enjoyed in common by millions or more people living under separate and distinct governmental jurisdictions along and in the vicinity of the boundary thus marked. Heretofore the exercise by the people of both countries of this common right to the use of these waters without international agreement or other limitation has, as we are informed, led to frequent and sometimes serious and acrimonious controversies and diplomatic negotiations between the two governments. These controversies have extended over a period of more than 15 years. At times they became so serious as to threaten destruction of private property.

Conclusions and recommendations, therefore, as to the normal levels and other conditions surrounding the use of these waters, their future regulation and control and the limits within which the people on both sides of the boundary may hereafter exercise their common right to use these waters for sanitary and domestic purposes, for navigation, for fishing, for power, and for municipal and industrial purposes generally, to be of value to the governments must necessarily be based upon the most careful and thorough examination of all the facts essential to intelligent and correct conclusions and practical recommendations. While the work thus far has been conducted with all the expedition possible and at a minimum cost, to complete it will require at least as much time and labor as has thus far been expended.

At a representative meeting of the Niagara District Hydro Radial Union at St. Catharines, it was decided to ask the various municipalities in Lincoln, Welland, Haldimand and East Wentworth to petition the Hydro-Electric Commission at the [illegible] to make a survey for a proposed radial line through the peninsula.

MECHANICAL PURIFICATION OF SEWAGE

Description of Riensch-Wurl Screen as Used in German Practice.

THE Riensch-Wurl Separator Disc is now being used in a large number of German sewage screening plants. The following are interesting abstracts from an article by Engineer Endris, of Hamburg, Germany, which is being distributed by the Sanitation Corporation of New York City, who have obtained the Canadian patent rights to the Riensch-Worl and other German sewage apparatus:

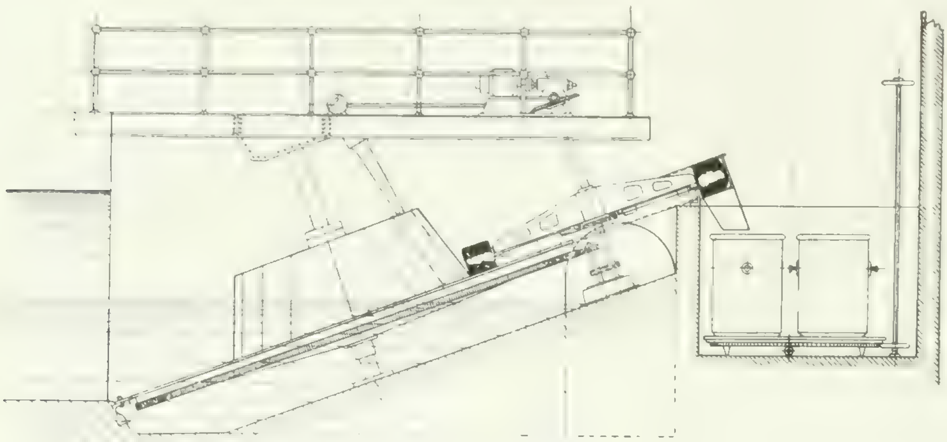

Fig. 1.—Elementary Outline of Riensch-Wurl Screen.

"The construction and method of the disc is clearly shown by the accompanying illustrations. It consists of a round disc provided with slots, the disc being suitably located at an inclined angle of 10 degrees to 30 degrees in the sewer, completely closing the cross-section of the canal. As Fig. 2 shows, the upper part of the disc extends above the water. The profile of the disc always conforms closely to the surfaces of the canals and has the advantage that the surface offered to the water entrance increases to the proportion of the rapidity of the increase in the canal profile, which is not the case in a rectangular pipe. The diameter of the disc is chosen to suit the volume of sewage and ranges between 1.3 to 8 m.

"The capacity of the disc depends upon the rapidity of flow, and the size of the slots, and is between 6 and 4,500 liters per second. The effluent of the main sewer is conducted diagonally against the disc. Shortly after the immersion of the rotating screen, it is covered with suspended matter, and during its travel through the water forms a sort of sludge filter, by which particles considerably smaller than the width of the slots are retained. On its exit from the water the screen is covered with solid substances of all kinds, as shown in Fig. 2. The solid substances are cleaned off above the surface of the water by a set of rotating brushes mounted on a spider, which revolve around the spider shaft and also on their own axis.

"In consequence of a special construction the bristles of the brushes are not pressed against the screen plate with too much force, nor the dirt squeezed through the slots, but the screen plate is gone over lightly and every spot brushed several times. The brushes carry the sludge into a circular trough, from which it is further transported by buckets, belt conveyer, tilting carts, or other device.

"In Fig. 1, the separator screen consists of two firmly connected parts, a smooth ring part, which lies diagonally in the sewage stream, and a hat-shaped frustum of a cone. The screen cone is cleaned by a special brush, the screen disc is in turn cleaned by revolving brushes.

"The usefulness of the screen depends particularly upon the construction of the screen plates which separate the solids from the fluids. They are made of bronze or brass, slots of cone shape, widened out on the under side about ½ to 5 m.m. wide. The screen plates are so arranged on the iron framework as to cause the least possible loss of head in the water.

"The screen surface, being made of large plates, insures a smooth and uniform surface without any projections on which sludge might possibly accumulate, while the close arrangement of the perforations provides the most advantageous possible use of the screen for the passage of the water.

"The framework (Fig. 1) is braced rigidly on all sides. All the load carried in a single one of the arms of the disc is cared for by a structural iron framework and is borne up by the main shaft itself. In the smaller and the medium sizes, up to 5 m.m. in diameter, the framework is secured to the carrying shaft and is hung to ball-bearing support which is supported by the service bridge. The ball-bearing support is constructed as pivot over the surface of the water. In the larger types (5 m.m. in diameter and over) the shaft is stationary and the framework of the screen rotates in a ball-bearing support arranged around the shaft above the water. In this way all the weight is taken up by the supports above the surface of the sewage and is easily cared for. A steady bearing is provided for the lower part of the main shaft, and consists of a roller bearing equipped with stuffing boxes.

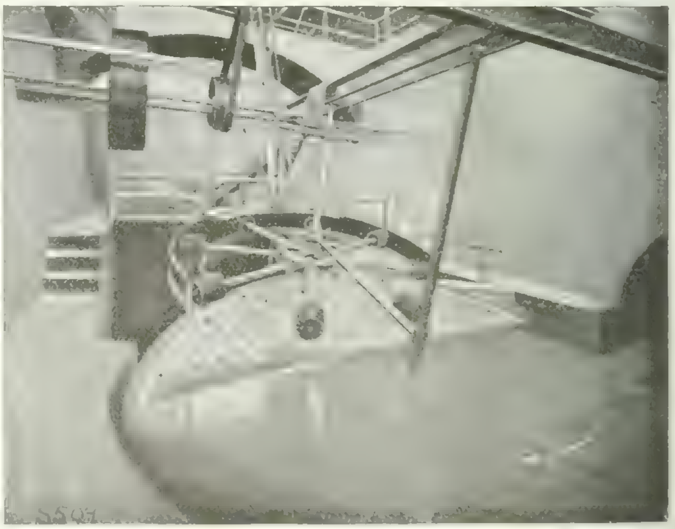

Fig. 2.—Riensch-Wurl Screen, Showing Method of Operation.

"Thorough lubrication, together with the slow rotatory movement (0.3-0.2 rotations per minute) and the small power consumed insures freedom from trouble.

"The manner in which the brushes are attached to a central brush body with radiating arms, makes the cleaning of the discs particularly efficacious. While in all other screen arrangements the screen surface is cleaned only once at each rotation the distribution of the brushes in the Riensch-Werl system permits the cleansing of the plates as frequently as desired. Normally, the screen plates are cleaned from 4 to 5 times each rotation in such a manner that a clean brush passes over the previously brushed surface. The brushes describe intersecting paths on the plates so that no single spot is left untouched by them.

"Summarizing the principle features of the screen:

"Large screening surface, high efficiency, low consumption of power and slight running expense, slight loss of head involved, adequate and substantial construction details, noiseless rotatory motion, and cleanliness. The mechanism is constantly in sight and the cleaning of it takes place above water; the clearance with walls of canal is precise and adjustable."

EFFECT OF CONCRETE ON STEEL.

That concrete has a preservative effect on steel has long been known, and many instances have occurred where ancient concrete has been broken away from metal with which it had been in contact for ages, and it has been found that the surface of the metal was as bright and clean as on the day when it was first placed in position. Some remarks made by Dr. W. H. Walker (the Director of the Research Laboratory of Applied Chemistry of the Massachusetts Institute of Technology) some little time ago will well bear repeating in this connection. Every engineer is well aware of the fact that acidulated water, no matter how small the percentage of acid may be, tends to corrode steel by increasing the number of hydrogen ions present, and Dr. Walker made it clear from the tests he carried out that there were certain alkaline substances present in concrete which corrected any acidity, and so protected the contained metal work from corrosion.

This fact has an important bearing upon the question, which lately has been much discussed, as to whether concrete will protect iron or steel from corrosion. Inasmuch as Portland cement, when it sets or hardens, liberates a quantity of caustic lime, which is a strong alkali, and since good concrete is saturated with this strong alkali, the answer to the question must be in the affirmative. Iron or steel will not corrode when embedded in concrete. But caustic lime is soluble in water, and poorly made concrete is not impervious to moisture. Therefore, if iron be embedded in concrete through which water is allowed at any time to percolate, this calcium hydrate will be slowly, but surely, dissolved. With it will disappear the inhibiting action of the concrete and iron embedded therein will, in time, rust and become corroded. To ensure absolute protection of the reinforcing members of concrete construction, therefore, such concrete must be of good quality, and sufficiently dense and carefully made to render it waterproof.

The Aztec Oil and Asphalt Refining Company of Canada have moved from the Shaughnessy Building, Montreal, to larger offices in the Power Building, Craig Street, Montreal.

ENGLISH FOR ENGINEERS.

By Benjamin P. Kurtz,
(In California Journal of Technology.)

When facts of iron and steel, of girders and trusses, are turned into a written report, they are presented no longer in their own tangible, objective medium or material, but in the new and subjective medium of words. Now, in the first place, it is to be noted that in this passage from the realm of objective reality to written representation there is ever present the dangerous chance of deflection of facts and even of their actual transformation—in a word, the danger of error. This merely because of the sudden transition to a new and unaccustomed medium. More narrowly regarded, however, the difficulty arising here is that of accuracy of statement plus the adaptation of technical facts and information to the laws and economy of mental attention. In order to gain and hold the attention of the reader, in order to present facts in such fashion that they may be easily and thoroughly understood, and that the general proposition may be seen to be supported at every point by its details, so that there is the mutual proof of a complete harmony between parts and the whole—in order to accomplish this successful communication with another mind, it at once becomes necessary to marshal the objective facts or material in such fashion that they will find a ready, orderly, and emphatic entrance into the mind of the reader. Facts without grouping dissipate the attention; poor grouping, overlapping, division, insufficiently marked separation confuse the attention; diffuse, wandering connections weary the attention; neglect to distinguish between division and implication, or between fact and hypothesis, muddle the conception of the reader; tortuous and nebulous sentences befog the conception of the writer; insufficient recognition of the necessity of exemplification and illustration, and ignorance of their difference, leave the reader too much to do or undo; the very lack of knowledge of what constitutes a definition, and of the fundamental methods of expanding a logical definition, lay the entire argument open to objection or render its outlines amorphous. In two words, the necessity of being understood, not the achievement of truth; the necessity of presenting groups of facts in accordance with the habits of trained thought-attention, not the accuracy of turning one fact into one phase—this is that new labor and skill required of the technician when he expounds his facts and thoughts to other minds in the medium of words.

BRIQUETTING OF SLACK.

"Conservation" calls attention to the fact that much coal is never utilized in Canada through piling the slack into huge "dumps." Such material is very valuable, and by means of a briquetting plant, may be converted into fuel of commercial value. Tests made in the United States show that the cost per ton of briquettes loaded on cars, from a briquetting plant at the mine would vary from about $3.50 to $5. The binder used is tar, which may be obtained as a by-product in the manufacture of coke. The briquettes withstand weathering better than ordinary coal, and there is less waste in shipment.

Renewed application will be made to the Railway Commission to order a start by the C.P.R. on its proposed freight tunnel from Burrard Street to the False Creek yards, according to a recent decision of the bridges and railways committee of the city council.

SOME LARGE CONCRETE BRIDGES

EXAMPLES OF THE APPLICATION OF CONCRETE TO BRIDGE DESIGN FOR VARIOUS USES—DETAILS OF THE IMPORTANT CONCRETE BRIDGES.

By L. S. BRUNER, A.M. Can. Soc. C.E.

CONCRETE, in its modern meaning, has been used in bridge construction for a great many years. While at first these structures were rather small, there has been a gradual increase in the length of the spans and length over all until at present we see arches of over 300 feet and viaducts of from half a mile to several miles in length.

Paulin's Kill Viaduct, D.L. & W.RR.—1,100 ft. long, 115 ft. above water.

The last few years have witnessed a remarkable growth in the use of concrete for long bridges and viaducts. They have been used for all classes of traffic, from those over which the traffic is entirely vehicular, to combined vehicular and trolley, and also railways.

One of the earlier of these immense structures was the Walnut Lane bridge in Philadelphia. It spans the Wissahickon Creek, the valley of which is a part of Fairmount Park, and connects Germantown and Roxborough, two of the city's finest residential districts. Prior to the construction of this bridge all traffic between the districts had to make a wide detour.

The total length of the bridge is 585 feet, consisting of a main span of 233 feet and five secondary spans. No reinforcement was used in the arch construction. The roadway is 150 feet above the creek and has a width of 56 feet, including sidewalks. The total cost was $262,000.

Concrete was decided upon principally for two reasons. In the first place the surroundings were such as to warrant a structure that would be in keeping with the natural beauty of the valley with its high wooded slopes on either side of the winding creek. Further, it was recognized that the maintenance of concrete would be very slight, due to the nature of the material and its great durability. While a fund for maintenance could have been provided for in any other class of structure, there was always the danger that the actual repair work might be neglected and the bridge become dangerous or unsightly, due to lack of proper care.

Following the construction of the Walnut Lane bridge, large concrete bridges and viaducts seemed to spring up all over the continent as well as in other parts of the world. Hardly was this bridge started before the Salt Lake, Los Angeles and San Pedro Railroad began the construction of a reinforced concrete bridge 1,000 feet long over the Santa Ana River at River Side, California.

Black Bay Bridge, Current River, Port Arthur, Ont.

The year 1910 saw the completion of Medina River bridge at San Antonio, Texas; the Almendares bridge at Havana, Cuba; and the Rocky River bridge at Cleveland, Ohio. The last named bridge was the largest of these, having a total length of about 800 feet and a main span

Allentown Viaduct—2,650 ft. long, 140 ft. high.

of 280 feet, 47 feet longer than that of Walnut Lane. This bridge is 100 feet high and contains 26,000 cubic yards of concrete. It was completed at a cost of $208,302.

All kinds and conditions of construction are represented in the later bridges. The Risorgimento bridge at

Munro Street Bridge, Spokane, Wash.

Rome, Italy, with a span of 328 feet, is built on a pile foundation, the soil being almost a liquid mud. The Dallas-Oak Cliff viaduct in Texas, the total length of which is 4,778 feet, has 51 arches, almost all of which are founded on piles. Spokane, Wash., subject to great extremes of temperature, boasts two of the larger structures. The first, Monroe Street bridge, has a main arch of 281-foot span and a length over all of 784 feet. The second bridge, completed last year, is 940 feet long.

Quite a few of these bridges are over a thousand feet in length. These are: West 7th Street bridge, Fort Worth, Texas, 1,041 feet; Dan River bridge, Danville, Virginia, 1,064 feet; Martin's Creek viaduct, Kingsley, Pa., 1,200 feet; Connecticut River bridge, Washington, D.C., 1,341 feet; Penn Street bridge, Reading, Pa., 1,350 feet; Delaware River bridge, Yardley, Pa., 1,446 feet; Colorado Street bridge, Pasadena, Cal., 1,470 feet; Catawba River bridge, Charlotte, N.C., 1,670 feet; Main Street viaduct, Fort Worth, Texas, 1,752 feet; King's Highway viaduct, St. Louis, Mo., 1,857 feet; Grand Avenue viaduct, Milwaukee, Wis., 2,088 feet; Tunkhannock Creek viaduct, Nicholson, Pa., 2,230 feet; South Eighth Street viaduct, Allentown, Pa., 2,600 feet; Dallas-Oak Cliff viaduct, Texas, 4,778 feet, and the Galveston, Texas, causeway, 12,642 feet.

More complete details of the most important bridges are given in the table on next page.

Walnut Lane Bridge, Philadelphia.

The Ford Motor Company are looking for an appropriate site for the construction of a large assembling plant at or close to Winnipeg.

The Metal Shingle and Siding Company, with headquarters at Preston, Ont., has decided to establish a branch at Regina, Sask.

For the first three months of the year the British coal and coke shipping trade exceeded 18,234,300 tons, as compared with 18,028,400 tons for the corresponding period of 1913.

It is reported from Sarnia, Ont., that a prominent manufacturing firm in the United States is looking for a good location at Point Edward, on which it intends to build a good-sized plant for the manufacture of a creosote preparation for use on block pavements and railway ties.

Definite word has been given to the Mayor of Medicine Hat, Alta., to the effect that the Maple Leaf Milling Co. of Toronto will commence construction on its plant at Medicine Hat in May; and also the Ontario and Manitoba Milling Company will commence construction on a plant very shortly. The two companies represent an investment of about $2,000,000. This word follows upon the recent statement that the Saskatchewan Bridge and Iron Works will commence its $1,000,000 plant at Medicine Hat within 30 days.

The Asphalt and Supply Company Limited, of Montreal, have moved from the Transportation Building to larger offices in the Board of Trade Building, Suite 303 to 307.

Announcement is made of the 14th annual 6 weeks' summer school of the College of Engineering of the University of Wisconsin, which opens on June 22nd. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shopwork and surveying, in addition to which, subjects may be taken in the College of Letters and Science.

Gifford-Wood Company, of Hudson, N.Y., are celebrating the 100th anniversary of the founding of their business. In 1814 Elihu Gifford, grandfather of the present general manager of the company, founded the business at Hudson. In 1905 the business founded by the Gifford family was amalgamated with the firm of William T. Wood and Company, of Arlington, Mass. The Wood firm also dates back to the very early part of the 19th century. In commemoration of the 100th [illegible] the firm [illegible] a handsome souvenir booklet, giving photographs of the works; of the executive staff; and of the ice-handling machinery, ice tools, coal-handling machinery, elevators and conveyers, and other equipment which they manufacture.

DETAILS OF SOME LARGE CONCRETE BRIDGES

Location	Name	Length	Width	Height	Number of Arches	Longest Spans	Cost	Cu. Yds Concrete	Tons Reinforcing Steel	Year Completed	Designing Engineers	Contractors
Spokane, Wash. ..	Monroe Street	784	68	130	3	281	$ 487,000	25,000	.....	1912	C. McIntyre, City Engr.	Day labor.
St. Louis, Mo. ...	Kingshighway Viaduct	1,857	90	..	15	170	387,000	26,010	1,500	1912	A. C. Janni, City Engr.	Wm. P. Carmichael Co.
Rome, Italy	Risorgimento	...	65½	51	1	328	235,000	......	.....	1911	La Societa Porcheddu.	Porcheddu & Bentivegna.
Dallas Oak Cliff, Tex.	Viaduct	4,778	53	60	51	79.5	570,000	......	.....	1912	J. G. Hedrick. L. R. Ash, Kansas City.	Corrigan, Lee & Halpin, Kansas City.
Fitchburg, Mass. ..	5th Street	651	40	..	6	200	....	5,000	420	1913	J. H. Fuertes, New York.	McHarg Barton Co., N.Y.
Reading, Pa.	Penn Street	1,350	80	43	14	5-110	....	......	.....	....	B. H. Davis, New York.	L. H. Focht, Reading, Pa.
Pasadena, Cal.	Colorado Street	1,470	38	175	9	223	188,000	11,000	600	Erecting	Waddell & Harrington, Kansas City.	Mercereau Bridge Cons. Co., Los Angeles.
Des Moines, Ia. ...	Walnut Street	503	84½	..	6	75	167,661	10,897	316	1911	City Engr. Dept.	John Wheeler Cons. Co., Geneva, Ill.
Riverside,[1] Cal. ...	Santa Ana Bridge ..	1,000	..	60	10	100	1,000,000	12,500	None	1909	....	....
Allentown,[2] Pa. ...	S. 8th Street	2,600	46	125	9	120	500,000	......	.....	....	B. H. Davis, New York.	McArthur Bros. Co., N.Y.
Yardley,[3] Pa.	Delaware River	1,446	66	70	14	91	....	34,670	263	....	Wm. Hunter and W. S. Maloney.	Talbot Cons. Co., N.Y.
Spokane, Wash. ..	Latah Creek	940	59	139	7	150	416,000	......	.....	1913	Waddell & Harrington.	J. E. Cunningham.
Danville, Va.	Dan River	1,064	23	..	13	158′ 7″	39,410	2,804	148	1911	W. J. Watson & Co.	Thomas Sheehan.
Pittsburg, Pa.	Atherton Ave.	377	53	50	3	98	95,000	8,000	175	1913	Pittsburg Engr. Dept.	Crawford Cons. Co.
Charlotte, N.C. ...	Catawba River	1,670	..	..	5[4]	161	70,000	......	.....	1912	W. J. Watson & Co.	C. W. Reynarth Co.
White Plains, N.Y..	Rye Outlet	924	25	100	5	129	....	......	.....	1911	N.Y. City Engr. Dept.	H. S. Kerbaugh, Inc., Phil.
Havana, Cuba	Almendares	711	34	48	3	190	217,751	12,820	195	1910	Barclay Parsons & Klapp	Barclay Parsons & Klapp.
Asheville, N.C.	French Broad River.	932	30	50	2	145	70,000	......	.....	1911	R. P. Johnston, Ashville.	Clark & Co., Baltimore.
Fulton, N.Y.	Broadway	700	48	..	5	145	....	......	.....	1913	Concrete Steel Engr. Co., N.Y.	Day labor.
Cleveland, Ohio ..	Rocky River	800	56	100	3	280	208,302	26,000	.....	1910	A. B. Lea, A. M. Felgate.	Schillenger Co., Toledo.
Philadelphia, Pa. ..	Walnut Lane	585	56	150	6	233	262,000	......	.....	1908	H. H. Quimbly, Phila.	Reilly & Riddle.
Galveston,[5] Tex. ..	Causeway	12,642	66	12	28	70	1,625,000	74,000	2,620	1912	Concrete Steel Eng. Co., N.Y.	A. M. Blodgett Cons. Co., Kansas City, Mo.
Port Arthur, Ont. .	Current River	212	26	33	1	130	15,484	......	.....	1911	City Engr. Dept.	Seaman & Penniman, Ft. William, Ont.
Pittsburg, Pa.	Larimer Ave.	670	50	110	8	312	170,000	9,471	446	1912	Pittsburg Engr. Dept.	J. F. Case Co., Pittsburg.
Nicholson,[6] Pa. ..	Tunkhannock Viaduct	2,230	34	240	10	180	....	164,000	1,140	Erecting	D. L. & W. R. R	Flickiver & Bush, N. Y.
Kingsley, Pa.	Martins Creek Viaduct	1,200	34	150	9	150	....	......	.....	....	J. G. Wray, Chief Engr., Hoboken, N.Y	....
Fort Worth, Tex. ..	Main St. Viaduct ..	1,752	70	..	4	225	373,952	......	.....	Erecting	Brenneke & Fay, St. Louis.	Hannan, Hickey Bros. Cons. Co., St. Louis.
" " " ..	West 7th St.	1,041	..	..	..	...	....	......	.....	.	....	....
" " " ..	Samuels Ave.	438	..	..	..	...	650,000	......	.....	Erecting	....	....
" " " ..	E. 4th St	438	..	..	..	...	....	......	.....	..	....	....
San Antonio, Tex. .	Medina River	330	..	65	3	110	25,000	......	53	1910	Tarrant Cons. Co., Forth Worth.	....
Milwaukee, Wis. ..	Grand Avenue Viaduct	2,088	67	80	10	145	550,000	45,000	270	1911	Concrete Steel Engr. Co., N.Y.	National Engr. & Cons. Co., Milwaukee.
Washington, D.C. .	Connecticut R. Bridge	1,341	52	120	7	150	850,000	......	None	1907	Geo. S. Morrison.	....
Bern, Switz.	Halen	787	33	131	5[4]	286	100,000	9,020	121	1913	J. Bollinger, Favre & Co., Zurich, Sw.	Müller, Zerrleder & Gobat, Bern, Switz.

1. Salt Lake, Los Angeles and San Pedro Railroad.
2. 8% Grade.
3. Philadelphia & Reading Railway.
4. Also several girder spans.
5. Railroad, Trolley & Highway
6. Delaware, Lackawanna & Western Railroad

STUDIES IN POWER STATION ARCHITECTURE

Some competitive designs executed in the Department of Architecture, University of Toronto.

Designed by A. Curry Wilson.

Designed by Mitchell Denison

STUDIES IN POWER STATION ARCHITECTURE

Some competitive designs executed in the Department of Architecture, University of Toronto.

Designed by LESTER HUSBAND.

Designed by HUGH A. HEATON.

The Canadian Engineer

ESTABLISHED 1893.

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ARCHITECTURE IN ENGINEERING WORK.

During the last few years considerable attention has been paid to the aesthetic appearance of the engineer's work, especially in the larger undertakings. Much, however, might be accomplished to render the engineer's solution of the smaller problems not only economical and useful, but pleasing features of the landscape.

Mr. C. H. Mitchell, Consulting Engineer for the Dominion Water Power Branch, in designing a small power station to be situated near Banff in the Rocky Mountain Park, offered prizes to the students in the Department of Architecture of the University of Toronto for suggestions of an architectural treatment. There were fifteen designs submitted by the students, all of which have considerable merit and offer valuable suggestions to the engineer in his study of similar problems. The students of the University were all intensely interested in the solution of this problem, and the staff in charge have expressed themselves as feeling greatly indebted to Mr. Mitchell, and also to the Commissioner of Dominion Parks, Mr. Harkin, and to Mr. Challies, both of whom not only gave their consent, but were kind enough to loan photographs of the surroundings of the intended station.

The award of the competition was as follows:
First prize—A. C. Wilson.
Second prize—M. Denison.
Third prize—L. Husband.
Mention—H. Heaton and H. R. Watson.

It is perhaps needless to inquire if our readers concur in the opinion that certainly all those power stations erected for the public, especially those located near any tourist centre, should have some such local feeling and architectural character as represented by the illustrations appearing in this issue. The local governments, as well as the federal, could do much to educate and refine their citizens if more attention were paid to these matters.

THE GOOD ROADS CONGRESS IN MONTREAL.

The provisional programme of the Canadian and International Good Roads Congress to be held in Montreal during the week of May 18th, has just been issued. The following speakers, together with their subjects, are among those who will take part in the proceedings:

W. H. Connell, Chief of Bureau, Department of Public Works, Philadelphia, Pa.—"Important Considerations Entering Into the Selection of Pavements for Roads and Streets."

R. W. Brock, Deputy Minister of Mines, Dominion Government, Ottawa, Ont.—"Road Materials and Their Use."

Arthur H. Blanchard, Professor, Highway Engineering, Columbia University, New York—"Modern Bituminous Surfaces and Bituminous Pavements."

W. A. McLean, M.Can.Soc.C.E., Provincial Highway Engineer, Department of Public Works, Province of Ontario, Toronto, Ont.—"Highway Legislation."

A. T. Laing, Lecturer, Highway Engineering, University of Toronto,—"Technical Training of Highway Engineers."

Archibald Curry, C.E., City Engineer, Ottawa, Ont.—"Macadam Roads With Bituminous Tops."

E. A. James, B.A.Sc., Consulting Engineer, York County Highway Commission, Toronto, Ont.—"Maintaining Macadam Roads."

T. Hugh Boorman, Treasurer, The American Society of Engineering Contractors, New York City—"Modern Road Construction in the United States and England."

Hyndman Irwin, B.A.Sc., Editor, *The Canadian Engineer*, Toronto, Ont.—"The Relation of the Technical Press to the Good Roads Movement."

Paul D. Sargent, M.Am.Soc.C.E., Chief Engineer, State Highway Commissioner of Maine, Augusta, Me.—"Development of the State Highway System in Maine."

B. Michaud, Deputy Minister of Roads, Province of Quebec, Quebec City—"Highway System of the Province of Quebec."

Lieut.-Col. W. N. Ponton, Hon. President, The Ontario Associated Board of Trade, Belleville, Ont.—"Good Roads as a Factor in the Progress of Cities and Towns."

Dr. E. M. Desaulniers, Chambly County, M.L.A., St. Lambert, P.Q.—"Road Legislation of the Province of Quebec, Compared With Other Provinces."

Major W. W. Crosby, Consulting Engineer, State Highway Commission, Baltimore, Maryland; R. A. Meeker, Engineer, Department of Public Works, New Jersey; Jean de Pulligny, Chief Engineer, Bridges and Roads, and Director of the "Mission Francoise d'Ingenieurs aux Etats-Unis," and others, have also signified their intention of being present and of reading papers.

Among the exhibits will be that of the Department of Public Works of the Ontario Government consisting of a series of minature models showing the development of road building from the early Roman roads to the types in use at the present time.

LETTER TO THE EDITOR.

North Toronto Sewerage System.

Sir,—With reference to the article appearing in the Toronto Evening Telegram of April 28, 1914, giving some opinions of Mr. T. Aird Murray on the North Toronto sewerage system, I would like, as a civil engineer, to draw your attention to a statement made in one of the closing paragraphs.

Mr. Murray refers to the city engineering officials as being "wedded to the old-fashioned combined sewerage system, . . ." I beg to take objection to the use of the term "old-fashioned."

It is an idle question to ask whether the separate system is superior to the combined system. Under certain conditions the latter may be better, for others the former may be more suitable. More correctly speaking, all depends on the local condition, especially on the condition of the flowing river into which the effluent is led and on the method of purification adopted. Since both systems are nearly equal as far as traffic and public health is concerned, the question of cost only is decisive with respect to which is to be preferred in the locality under consideration.

As to the separate sewerage system, the public sewers can be easily adapted to the fluctuations of flow. They consequently can be designed with small cross-sections in which the velocity and cleansing action are relatively large and uniform. The cross-sections are usually calculated for maximum capacity running full. The filling up of the half section will then probably be obtained daily for some time. Deposits of putrescible matter seldom occur and these can be easily removed by regular flushing which, owing to the small cross-section, requires only a small amount of water. The formation of gas is very slight. In consequence of the frequent filling of the sewer an ample circulation takes place.

The storm sewers are carried on the shortest route to the nearest river or flowing water. By avoiding all long routes better grades and correspondingly smaller cross-sections are obtained. At the same time, the rain water pipes can be laid at smaller depths as they have not to drain deep cellars.

For the separate system the surface water is carried off either completely or partially. The saving is important by the omission of storm sewers. As soon as nuisances are caused to the traffic by the superficial removal of the rain water, or nuisances of any other kind are created, a new layout of a storm sewerage system can always be effected.

The separate system is always an advantage if the stream into which the effluent is to be discharged can be reached by means of short sewers, while the combined flow, on the contrary, has to be conveyed for a long distance on a flat grade. The route of transportation of the large quantities of storm water is, in this case, shorter with the separate system. The long sanitary sewers having only small cross-sections, thus the cost of removal per unit of quantity of sewage (storm and sanitary flow) is less than the removal in a common conduit.

Likewise, the separate system is preferable if the sewage has to be pumped to a higher elevation while the storm water runs off by gravity on a natural grade. A further advantage is that the house connections in the separate system for the conveyance of the sanitary flow are not liable to be backed up by heavy showers in the sewers which may be of value in flat districts.

In the case where the storm sewers cannot be carried to rivers closely located, the twin sewers of the separate system are always more expensive than the simple combined system, and the latter is to be preferred.

A great factor in favor of the separate system is indeed the easier purification of the sewage in consequence of the more uniform condition.

However, it is often necessary to lay out a complete scheme on the separate and on the combined system in order to compare the two. Here it is necessary to bear in mind that the house connections of the separate system cost twice as much as those of the combined, apart from the fact that the construction requires more careful attention necessary to prevent the storm water finding its way into the sanitary sewers.

From what I have said and in spite of the undeniable advantages of the separate system, there is no reason to call, as an adherent of one system, the other old-fashioned. Such a behavior shows narrow-mindedness and deserves no consideration. The cost of the sewerage system, the method of purification to be adopted, and the condition of the flowing stream are the only decisive momenti.

Therefore, if a combined system is installed, the objectors can only conclude that one has considered more the experience and ability of an engineering expert than the inciting myopia of would-be engineers.

ERWIN KOHLMANN,
Dr.-Ing., Dipl.-Ing.

Toronto, April 29, 1914.

[NOTE—The foregoing letter refers to an extensive sewage project recently recommended by Mr. R. C.

Harris, Commissioner of Works, Toronto, for that section of the city formerly known as the town of North Toronto. The scheme calls for a combined system, the estimated ultimate cost being $4,144,256. The improvement divides the district into two sections at Eglinton Avenue. In the section north of Eglinton Avenue it is proposed to construct lateral sewers to cost $422,000 and thirteen trunk sewers to cost $584,644. Two storm outlet sewers are provided, the cost of which is estimated at $366,275. The sewage disposal plant for this district will cost $305,900 and consist of a stand-by tank for the treatment of storm water, detritus tanks, Imhoff tanks, chlorinating devices, sludge-drying beds and sprinkling filters.

The sewage disposal plant in Section 2, will be similar to the above, but of larger capacity, and will cost approximately $400,000. The work in this section involves the construction of lateral sewers estimated to cost $390,000 and seven trunk sewers costing $648,000. Two storm outlet sewers will cost about $360,000, while a dry-weather-flow sewer to the disposal works is also proposed. It should be stated that the estimate of each disposal plant includes a site for future development and that each trunk sewer will have a superficial area exceeding four square feet.

In the interview to which Mr. Kohlmann refers, Mr. Murray, who designed the present system of sewage in North Toronto, criticises the expenditure of $4,000,000 on the proposed combined system. The present system was designed on the separate plan, to take domestic sewage only with a small proportion of roof water where necessary, but no surface water. Mr. Murray contends that the separate system is the only suitable one for the district, claiming that the purification point of view is one of the chief considerations relative to its sewage system as the practice of discharging sewage into the Don River must be continued for some time. In pronouncing the separate system of sewage as the ideal one for a suburban district such as North Toronto, which will probably be free from manufacturing industries, Mr. Murray alludes to the excessive cost of the project as outlined above and refers, as Mr. Kohlmann states, to the city engineering officials as being wedded to the old-fashioned combined sewage system. Hence Mr. Kohlmann's criticism.—Editor.]

A NEW STEEL SHEET PILING SECTION.

A new form of Lackawanna steel sheet piling section is now being rolled for use in 90-degree corners of rectangular cofferdams or retaining walls, either with the hook or guard on the outside. These rolled corners overcome the necessity of using specially fabricated and less easily driven corners. Moreover, they weigh less per lineal foot than the fabricated corners, and can be used wherever the conditions of load are not excessive. With the flexibility characteristic of this make of joint the two new corners will meet most requirements.

The Port Arthur city council has been approached by J. Stewart of Chicago with a request for a favorable consideration of a proposal for the location of a coal gas plant at Port Arthur. The matter is being considered by the industrial committee of the council

It has been reported that the Standard Oil Company has entered into an agreement with the Chinese government, or with Yuan Shih-Kai, the dictator president, for the control of the extensive oil fields of northern Shensi. The amount paid by the company for this concession is not known.

SEWAGE POLLUTION OF BOUNDARY WATERS.

THE investigation into the pollution by sewage of the boundary waters between Canada and the United States has received frequent mention in *The Canadian Engineer.* The whole subject is being well summed up by Dr. Allan J. McLaughlin, chief sanitary expert and director of field work for the International Joint Commission, in a paper to be read next week at the convention of the American Water Works Association, and published in the Journal of the Association for March, 1914. In December, 1910, Dr. McLaughlin was directed to investigate the sewage pollution of interstate and international waters with special reference to the spread of typhoid fever. In 1911 he completed a sanitary survey of the entire watershed of the Great Lakes on the United States side of the boundary. Briefly the conditions found were as follows:—

An excessive prevalence of typhoid fever, especially in the winter and spring months, punctuated at intervals by explosive epidemics. This excessive prevalence of typhoid fever especially in the winter and spring months was due in greatest measure to the unrestricted discharge of sewage into interstate and international waters used as sources of public water supplies. Disaster followed the use of this sewage polluted water for one of two reasons, either a failure to purify or the inefficiency of the attempted purification.

The delusion that water from the Great Lakes or their connecting rivers needs no purification has been cherished for years in our cities and even with our disgraceful record of waterborne typhoid and the lessons of numerous disastrous epidemics, it is still no easy task to convince municipal officials that purification of these waters is necessary.

The remedies suggested by the writer at that time were:—

1. Safe water supplies, that is, water shown to be safe by daily bacteriologic examination.
2. Supervision and control of water supplies by the state to ensure efficiency and a safe effluent at all times.
3. Control of sewage discharge within permissible limits to prevent an unreasonable burden or responsibility upon filter plants.
4. Prevention of pollution from vessels.

In order to secure efficient and uniform results from the application of these remedies, he recommended that two sets of standards for water be formulated.

1. Standards for filtered or treated water.
2. Standards for raw water at the intakes.

In accordance with this recommendation in January, 1913, the U.S. Surgeon-General appointed a commission for the determination of a standard of purity for drinking water, and the report of that commission will soon be published. This report will furnish a minimum standard to which all common carriers, trains and vessels must conform to prevent the spread of disease in interstate traffic. This furnishes the first standard recommended. The fixing of the second standard or standard for raw water at the waterworks intakes is a much more complex problem. However, great strides have been made in this direction also.

A committee of the national association for the prevention of pollution of rivers and waterways, made up of Geo. C. Whipple, Edward Bartow, Geo. M. Wisner, H. W. Clark, and Dr. McLaughlin, studied the problem of standards in a general way and agreed upon certain fundamental principles which made a very good starting

point for more intensive studies. This brings us to the work of the International Joint Commission.

The term Commission is misleading, as this body is in reality a tribunal formed under the treaty of January 11, 1909, between Great Britain and the United States to prevent disputes regarding the use of the boundary waters and to settle questions now pending or which may arise hereafter between the United States and Canada, involving the rights, obligations or interests of either in relation to the other or the inhabitants of the other along their common frontier. In addition to their judicial powers the Commission, under Article IX. of the treaty, is empowered to investigate and report upon such questions as may be referred to it by the two governments. It is provided that such reports under Article IX. shall not be regarded as decisions of the questions and shall in no way have the character of an arbitral award under this investigative function.

The question of pollution of boundary waters was referred to the Commission by the two governments. The reference was in two sections, the first dealing with the location, origin and extent of pollution and the second dealing with remedies. The text of the reference was as follows:—

1. To what extent and by what causes and in what localities have the boundary waters between the United States and Canada been polluted so as to be injurious to the public health and unfit for domestic or other uses?

2. In what way or manner, whether by the construction and operation of suitable drainage canals or plants at convenient points or otherwise, is it possible and advisable to remedy or prevent the pollution of these waters, and by what means or arrangement can the proper construction or operation of remedial or preventive works, or a system or method of rendering these waters sanitary and suitable for domestic and other uses, be best secured and maintained in order to insure the adequate protection and development of all interests involved on both sides of the boundary, and to fulfil the obligations undertaken in Article IV. of the waterways treaty of January 11, 1909, between the United States and Great Britain, in which it is agreed that the waters therein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other?

The Commission took up first the question of location, origin and extent of pollution. At the Detroit session February 20, 1913, Dr. McLaughlin was placed in charge of the investigation as chief sanitary expert and director of field work. Associated with him on the Canadian side were Dr. John W. S. McCullough, Chief Health Officer of Ontario, and Dr. John A. Amyot, Professor of Hygiene, University of Toronto. Canadian laboratories were established at Fort Frances, Port Arthur, Sault Ste. Marie, Sarnia, Windsor, Amherstburg, Port Stanley, Fort Erie, Niagara-on-the-Lake and Kingston, Ontario, and Montreal. American laboratories were established at Port Huron, Michigan, Detroit, Michigan; on U.S. Revenue Cutter "Morrill"; Buffalo, New York; Youngstown, New York; Clayton, New York; and Van Buren, Maine.

In the interest of economy and efficiency it was deemed wise to utilize such established governmental agencies as might be available for the field investigation. Accordingly the co-operation of the United States Public Health Service, the Provincial Boards of Health of Ontario and Quebec, the State Board of Health of Michigan, and the Department of Health of the State of New York was secured and was of very great value to the Commission in carrying out the work.

The work extended from the Lake of the Woods through the entire chain of the Great Lakes and St. Lawrence River to the St. Johns River on the Maine—New Brunswick border. Field work began in April and terminated November 1. There were over 1,400 sampling points and over 19,000 samples taken and examined bacteriologically. The report presents as indices of pollution the average number of the colon bacillus per 100 cc. of water and the number of bacteria per cubic centimeter of water. The results of the investigation are shown by averages in concise form for each sampling point and cross-section by tables and colored maps. In addition, diagrammatic representation is employed to show the degree of intensity of the area of pollution in each section of the boundary waters. In certain localities on the Great Lakes and in all their connecting waters dangerous sewage pollution was shown to exist, but the bulk of the Great Lakes waters remains in its pristine purity. The investigation shows that the colon bacillus is practically never present in unpolluted waters, and that the normal bacterial content of Great Lakes water is less than 10 per cubic centimeter. Great Lakes water is classified tentatively into five classes in this report, from the relatively pure water through slight, moderate, serious to gross pollution. The sources of pollution in the order of their importance are sewage from cities, sewage from vessels navigating these boundary waters, and the inevitable pollution following rains and thaws. The distance pollution may travel in the Lakes was demonstrated also. At the mouth of the Detroit River and at the mouth of the Niagara River serious pollution extends normally more than 10 miles into the lakes and on occasion was found 16 to 18 miles from shore. The distances from the cities of pure water in the lakes, the enormous cost of long pipe lines, coupled with the engineering difficulties in placing intakes beyond a 70-foot depth, make it impracticable in most instances to secure pure water from the lakes without treatment. The present position of intakes is such that there is not a single municipality using lake water which can be said to possess a safe water supply without treatment.

As might be expected, the areas most grossly polluted are in the connecting rivers upon which large cities are situated. The pollution from vessels renders the St. Mary's River above the cities of Sault Ste. Marie unfit as a source of water supply without treatment, and vessel pollution combined with the sewage from the cities of Sault Ste. Marie cause gross pollution of the St. Mary's River from the Sault to Neebish Island.

Because of sewage pollution there is no point in the St. Clair River from which a safe water supply could be secured without treatment.

The Detroit River is polluted from Lake St. Clair to Sandwich sufficiently to make the water an unsafe source of water supply. From below Sandwich to its mouth the Detroit River is grossly polluted from shore to shore.

Gross pollution in the Niagara River extends along the American shore from Buffalo to Strawberry Island, throughout the entire Tonawanda Channel, and below the Falls gross pollution extends from shore to shore throughout the entire river and for miles out in Lake Ontario.

Investigation of the St. Lawrence River (Lake of the Thousand Islands) was made at two distinct seasons. The

results obtained in April showed a slight degree of pollution. The results obtained in August showed a greatly increased pollution obviously due to the increase in summer resort population and to the sewage discharge from vessels.

The report of the field work gives an accurate survey of the origin, location and extent of pollution and completes the first half of the reference. The Commission is about to take up the second half of the reference which relates to remedies for pollution.

Dr. McLaughlin's suggestion to the Commission in regard to proceeding with the second part of the reference consisted of three steps:

1. Secure the opinions of the most eminent sanitary engineers by submitting a list of questions. These opinions would form a sound basis for formulating a general policy and possibly some general minimum requirement.

2. Public hearings at which the municipalities could present their cases including expert engineering testimony, plans and projects.

3. Employment of expert sanitary engineers for the formulation of special standards for each waterway in excess of general minimum requirements depending upon local conditions and necessities.

It is probable that the Commission will proceed somewhat according to this outline. In so doing and in carrying out the third step formulation of special standards, we will realize the second of the essentials which are necessary for the protection of the public health, viz.: A standard for the raw water at the intakes.

The standard for raw water at the intakes in each locality seems to be the only means by which an equitable adjustment can be secured between the two agencies in producing safe water, viz.: water purification and sewage treatment.

In concluding his paper, Dr. McLaughlin strongly accentuates to the American Water Works Association the necessity for safe water supplies and he enumerates several cardinal necessities to be observed in the purveying of water to the public.

There has been entirely too much confidence in untreated surface supplies. A surface supply from an inhabited watershed is rarely safe without treatment and can only be said to be safe when daily bacteriologic examination shows it to be free from pathogenic or intestinal germs. To ensure safe water bacteriologic control is just as much a necessity for water purification plants as for untreated supplies. With a polluted source the mere installation of a purification plant does not guarantee safe water. Even if perfect in design and construction unless efficiently operated and controlled a safe effluent need not be expected. Reference was made to filter plants designed by very capable engineers—perfect mechanisms which if properly operated would produce safe water—placed in the hands of an assassin who was a promoted stoker and absolutely ignorant of bacteriology or chemistry.

Another point brought out referred to the adjustment of the balance between water purification and sewage treatment. He has seen very good filter plants struggling with a raw water which imposed an unreasonable responsibility upon the plant. A safe effluent under such conditions was secured at the price of eternal vigilance. filter plants are not infallible and their operators, even when skilled, are only human. Dr. McLaughlin believed a decent raw water should be made available for all plants and where necessary treatment of sewage should be carried at least far enough to secure this result.

The greatest obstacle to proper operation and control of plants has been the difficulty of securing the right man to place in charge of the plant. The best type of man for this position is a graduate in sanitary engineering. He will not only be conversant with the mechanical details of the plant, but will be able to adjust his chemicals according to the constituents and needs of the raw water. Most important of all, he will be able to make daily bacteriological examinations to determine the efficiency of purification. Nearly all the disasters due to sewage-polluted water supplies which have occurred were due to lack of daily bacteriological knowledge of the public supply or the inefficient operation of plants by unskilled men. The employment of such a graduate is economy even in small cities. There may be cases, however, where it is impossible, for economic reasons, to pay the necessary salary. In these cases local men must be employed, and trained to do the work. Here the Board of Health will find a very useful function. The State authorities could supervise the installation of a small, inexpensive laboratory equipment in small plants and give instruction to the local man in making the necessary water examinations. Whenever possible, however, young graduates of sanitary engineering schools should be employed; and such men are well worth their salary, considering the saving in the economical adjustment of chemicals and fuel costs made possible by intelligent supervision. The greatest asset, however, to be credited to skilled operation is the saving of human life effected and the satisfaction of knowing that safe water is being furnished every day.

The Mississippi River Commission, which met at St. Louis, Mo., on April 15, agreed to recommend that Congress appropriate $12,000,000 for the improvement of the river next year.

Approximately 500 mineral claims have been staked at Beaver Lake and registered at the Dominion land office at Prince Albert, Sask., since the rush to the goldfields commenced a few months ago, and 350 powers of attorney have been taken out.

At a general meeting of the Standard Oil Company of Canada, held on April 16, in London, Eng., resolutions were agreed to for the reconstruction of the company and the registration of a new company under the name of the Coatsworth Natural Gas Company, Limited. The capital of the new company will be £35,000.

The Commission of Conservation at Ottawa, acting in co-operation with the provincial governments, has been making an extensive investigation into the water-powers of the western provinces. Field parties have covered practically all the territory in these provinces, particularly in British Columbia, and a report will be issued shortly, giving full data, including the results of systematic stream measurements. The information respecting the water-powers in the eastern provinces was published in a report by the commission two years ago.

The following items of expenditure were given in the summary of capital expenditure published in the report for 1913 for the corporation of the city of Vancouver, B.C.:—

General Fund—	
Street and lane improvements	$582,322.86
Sewers	[illegible]
Bridges	217,674.96
Rock crusher and bunkers	10,167.15
Waterworks	678,416.40
C.P.R. subway	21,728.33
Local Improvements:—	
Cement walks and curbs	[illegible]
Pavements	[illegible]
Street widening	427,040.64
Opening lanes	17,899.13
Ornamental street lighting	38,608.21
Macadam roadways	832.85
Wooden curb	[illegible]
Resurfacing	[illegible]
Street and lane extensions	38.40

THE USE OF ELECTRICITY IN THE STEEL HARDENING ROOM.

By R. H. Cunningham, B.A.Sc.,
General Manager, Canadian Hoskins, Limited,
Walkerville, Ont.

IN April 16th, 1914, issue of *The Canadian Engineer* the writer attempted to present in a general way the heat treatment operation of steel known as the process of hardening, and to explain its effect in relation to the varying composition which the material may have. The article referred to the critical temperatures which were associated with steels of different carbon content, and touched upon the theory governing the peculiar phenomena and characteristics one found in connection with the process. The necessity of accuracy for good results in the hardening of carbon steel was emphasized, and it is the purpose of this article to describe a practical means of determining the correct temperatures upon which these good results depend.

The necessary apparatus for the process which the writer has in mind consists of a small electric furnace in which to heat a specimen of the steel to be tested, a special thermo-couple pyrometer for indicating the temperature of this specimen throughout its range of heating, and a specimen itself, properly shaped for clamping to the thermo-couple. The apparatus for this purpose, as shown in Fig. 1, illustrating what is known as the Hoskins' recalescent outfit has a crucible chamber 2 1/16 in. in diameter and 2½ inches deep. Heat is produced by means of the resistance offered to the passage of an electric current through the "resistor" or heating element. This "resistor" is of a special metal in the form of wire which is wound in close contact with the chamber

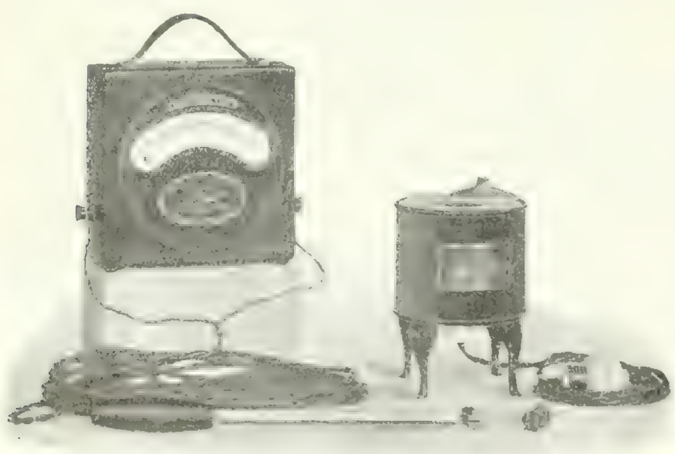

Fig. 1.—Recalescent Outfit. Note the two test specimens of steel, one fastened to couple.

lining. The furnace is designed so that it can be used on standard lighting circuits to which ready connection is made by means of a twin-conductor cord and lamp plug. In operation, it consumes 3½ amperes at 110 volts and is capable of producing a chamber temperature of 1,000° C. (1,832° F.) which is considerably higher than any required by a carbon steel.

The pyrometer of the outfit is of the thermo-electric type. This instrument embraces a thermo-couple, connecting leads and indicating meter. The thermo-couple is of small wire so as to respond quickly to any slight variation in temperature. The welded end of this couple is slightly flattened to enable the making of a good contact between it and the specimen of steel. The meter is portable and indicates temperatures up to 1,400° C. (2,552° F.).

The specimens of the steel to be tested should be small so as to heat quickly and uniformly. A well-formed specimen is made with two duplicate parts, each 1¼ inches long by ½ inch wide by ¼ inch thick. These pieces are clamped, by means of two ⅛ inch bolts, one on either side of the welded part or extreme end of the thermo-couple. Care is taken to form a tight contact,

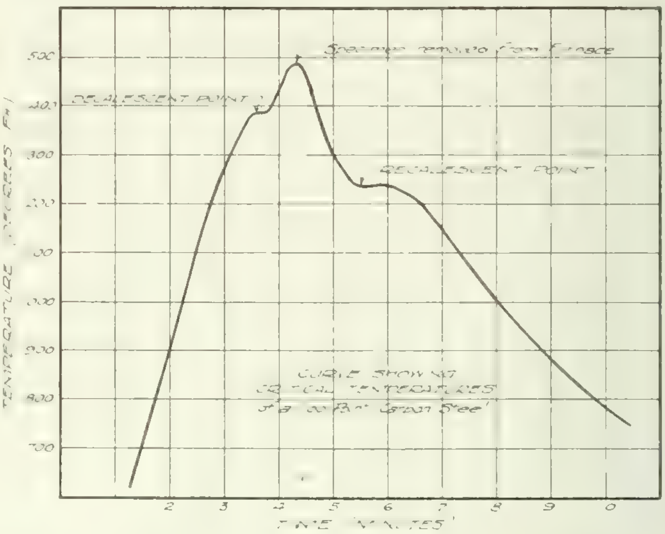

Fig. 2.—Heating-cooling Curve, Showing Location of "Critical Temperatures."

though not to cause an undue strain on the couple. The dimensions here given for the test specimen are not essential, though convenient; any pieces which will permit of tight contact with the thermo-couple and of ready heating in the furnace chamber, may be used.

Method.—With the specimen fastened to the couple, as just described, the furnace is connected in circuit and the cover placed over the chamber opening. The temperature within the chamber rises steadily. When it becomes 925° C. (1,700° F.) the end of the couple, with specimen attached, is inserted in the chamber.

The steel specimen rapidly heats up, its temperatures being constantly the same as that of the welded junction of the thermo-couple, due to the intimate contact between them. This temperature, indicated by the meter, will rise uniformly until the "decalescent" point of the steel which is being tested is reached. At this temperature the indicating needle of the meter becomes stationary, the added heat being consumed by internal changes instead of by increase of temperature. These changes completed the temperature again rises, the length of the elapsed period of time depending upon the speed of heating. With the furnace temperature kept constant at the initial point here given (925° C. or 1,700° F.), this "speed of heating" will be such as to allow of readily observing the pause in motion of the needle. The temperature at which this occurs should be carefully noted as it is the decalescent point.

To obtain the lower critical point, the temperature of the piece is first raised above the decalescent point by about 40° C. (104° F.). In this condition it is removed from the furnace and rested on top to cool. The decrease of temperature is at once noticeable by the fall of the meter needle. At a temperature somewhat below the

decalescent point, varying with the composition of the steel, as previously mentioned, there is again a noticeable lag in the movement of the needle. The temperature at which this ceases entirely is the recalescent point. Immediately following there may occur a slight rising movement of the needle, as explained under "Theory" in the preceding article already referred to.

During these intervals of temperature lag, on both the heating and cooling of the steel, there may occur a small fluctuation in the temperature. In order to get results that are comparable, a definite point in each of these intervals should be considered, each time a test is made. Hence both the decalescent and recalescent temperatures are taken as the points at which the needle first becomes stationary.

As all operations of heat treatment of a steel centre around its critical points, the importance of knowing these exactly is realized. To make certain, each test should be checked by a second reading. The time required for this is small. A close arrangement of two succeeding readings will give assurance of the correctness of the determination.

Results Obtained from Sample Specimens.—In order to show graphically the necessity of working carbon steels at the proper temperature points, here dwelt upon, a series of specimen pieces of the same steel were treated at different temperatures. The steel used contained exactly 1% of carbon. A number of test specimens were made of this from different parts of the same bar.

First, the critical points of this steel were determined. With the test furnace at a temperature of 935° C. (1,700° F.) the specimen, fastened to the welded junction of the thermocouple, was inserted in the chamber. When its temperature had exceeded the decalescent point of the steel by 100° F., or at 805° C. (1,480° F.) it was removed from the chamber and allowed to cool. Temperatures were recorded throughout both the heating and the cooling. In Fig. 2 these values have been platted. The curve shows graphically the location of the critical points, and also the retardation of motion which precedes these and the slight fall or rise of temperature, as the case may be, which follows them.

With this data obtained, 7 specimens of the same steel were heated, in the electric furnace, each to a different temperature. As these pieces were removed from the furnace they were immediately quenched in water. The temperature of the quenching bath was held constant at 45° F. These hardened pieces were then broken at right angles. The fractured surface of each was photographed under a microscope. These photographs are here produced in the same size as the originals—in Figs. 3 to 8 inclusive. Due to magnification, each of the first five of these represents a portion of a circular area of the actual steel, 0.05 in. in diameter; in the last two, of 0.1 in. in diameter.

An inspection of these shows at once the serious effects on its structure—and hence on its strength—of overheating a piece of steel. The specimen shown in Fig. 3 is very badly "burned," as evidenced by the extreme coarseness of its grain. The specimen in Fig. 4, hardened at 150° F. lower temperature, shows less coarseness, though still badly burned. The succeeding specimens show a gradual improvement, as the temperature at which they were hardened approaches the decalescent point of the steel. Fig. 8 shows a specimen which was quenched, just after the hardening change in its structure had become complete, at 5° F. above the critical temperature. The very fine grain and closely woven texture of this fracture show a properly hardened steel, one which has both the desired hardness and the maximum of quality.

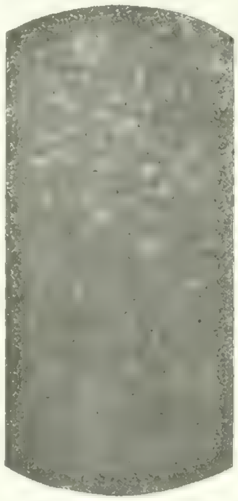

Fig. 3.
Quenched at 1900° F.

Fig. 4.
Quenched at 1750° F.

Fig. 5.
Quenched at 1600° F.

Fig. 6.
Quenched at 1510° F.

Fig. 7.
Quenched at 1425° F.

Fig. 8.
Quenched at 1385° F.

Fractured sections of carbon steel, carbon content 1%. (Figs. 3 to 7 inclusive magnified 50 diameters. Fig. 8 magnified 25 diameters).

The specimen shown by Fig. 9 was hardened just as the temperature reached the decalescent point. This illustration shows the direction in which the hardening moves, namely, from the exterior toward the interior. This would naturally be expected as the temperature of the surface—which is exposed directly to the source of heat—reaches the critical point first. As seen in the illustration, the structural change has been completed only in the surface layer—toward the corner—of the specimen. Here the grain is fine, the steel hardened,

while the interior is still in the unhardened state as evidenced by its coarser grain. This condition indicates the necessity of heating the piece uniformly.

While 1,900° F., the temperature at which the specimen of Fig. 3 was hardened, represents a very excessive heat, yet it is not infrequent that carefully machined parts are ruined by overheating to even this degree. The practice of guessing at hardened temperatures can only result in uncertainty at the best. Yet, by use of the apparatus here described, the correct hardening temperature of any carbon steel can be exactly determined.

The hardening of carbon steels for the highest quality and greatest saving entails, then, three things: First, a definite knowledge of what constitutes the correct temperature at which to harden the steel. The fundamental theory and facts underlying this have been presented in the article in April 16th issue.

The second point necessitates a positive means of accurately determining this hardening temperature for any carbon steel. The outfit described above is a direct and economical answer to this. The simplicity of the apparatus, its ease and certainty of operation, compel attention to its use. It makes possible the maximum quality in the finished steel, and the greatest saving in production cost.

(Magnified 25 Diameters.)

Fig. 9.—Fractured section of a 100-point carbon steel quenched just at its decalescent temperature (1380° F.), showing uneven hardening due to lack of uniformity of heat penetrations.

The third consideration is that the correct hardening temperature, once determined, is actually carried out in the hardening work. A simple and effective way of doing this is by checking the temperature of the hardening furnace by means of a pyrometer. For this purpose, the meter of the recalescent outfit may be used in connection with a second and heavier thermo-couple.

When there is a large quantity of work to be hardened, economy dictates a permanent installation of pyrometers. The convenience of such installations is manifest. A thermo-couple is placed in each furnace. A number of these, from three to sixteen, depending upon individual conditions, are connected by wire leads, through a selective switch to one meter. By a turn of the switch, the temperature of any furnace may be read at once from the meter. This makes it possible for the foreman, at a single point, to know definitely the temperatures of all of the hardening furnaces in use. It eliminates all guesswork, makes responsibility absolute and results positive.

Temperature Measurement.—The majority of industrial operations involving the production or utilization of heat require some reliable and practical means for measuring the intensity of heat. In some cases this is essential because the successful outcome of the operation depends upon a particular temperature. In others the cost of generating heat is the important consideration and it is then a matter of economy to know the temperature so that energy will not be wasted in generating surplus heat.

These well-known facts have been widely disregarded in industrial plants, in spite of resulting inefficiency and waste, because of a general lack of confidence in many of the devices which have been available for measuring temperatures where ordinary thermometers are not suitable.

This unsatisfactory state of affairs has existed because so many of these devices are totally unsuited to industrial work. They are either of the strictly laboratory variety, too fragile and expensive for shop use, or, if strongly enough built to stand hard usage, are correspondingly inaccurate and unreliable.

The pyrometer that has been developed by Hoskins Manufacturing Company will operate up to 2,300° F. for continuous service and 2,500° F. for intermittent use, and will handle the great variety of operations requiring heat. This is from 500 to 600° higher than recommended for any other type of base metal type pyrometer.

The Thermo-Electric Pyrometer.—These pyrometers are of the thermo-electric type, it being the most widely adaptable and practical of all temperature measuring devices for temperatures above the range of ordinary thermometers and up to approximately 1,370° C. (2,500° F.).

Briefly, the chief advantages of the thermo-electric pyrometer are that it gives direct readings of temperatures above the range of thermometers and that temperatures of one or many points may be taken at a central location distant from the source of heat.

The limiting low temperature for which the thermo-electric pyrometers are recommended is, under average industrial conditions, near 100° C., although they can be used to advantage below that temperature when proper provision is made for keeping the "cold-end" temperature constant.

For the benefit of those who are not familiar with pyrometers and to make clear the purposes and advantages of certain late improvements, the following explanation is given. The principle upon which the thermo-electric pyrometer operates is the measurement of a current of electricity generated by the action of heat on the junction of two dissimilar metals.

The thermo-electric pyrometer consists of two essential parts, namely, the thermo-couple and the meter. The thermo-couple, which generates the electric current, is composed of two wires of dissimilar metals connected at one end. This connected end of the couple is called the "hot end" and is placed in the furnace or heated space, the temperature of which is to be measured. Except at the hot end, the two wires, or elements, do not touch. The free ends are known as the "cold end" of the thermo-couple from the fact that this end of the couple is always kept away from the heat, and generally at the temperature of the outside air. When the hot end of the thermo-couple is heated it generates an electro-motive force, the intensity of which is determined by the difference of the temperature of the hot-end and the temperature of the cold end.

The meter is the indicating part of the pyrometer. It is connected by means of a pair of copper lead-wires to

the cold end of the thermo-couple and measures the current caused to flow by the electro-motive force of the thermo-couple.

Instead of indicating the value of the current in electrical terms the meter is calibrated to indicate directly in degrees F. or degrees C., as may be desired.

In order that the meter will indicate the actual temperatures of the hot end and not merely the difference between the temperature of the hot end and the cold end, the starting point of the meter must be set to agree with the temperature of the cold end. As the most convenient temperature for the cold end is that of the average room, the starting point or "zero setting" of the meter is usually at 25° C. or 77° F. for calibration.

Unless some special provision is made for the purpose, it is obviously impossible, in practice, to keep the cold end constantly at the room temperature for which the meter was calibrated. This variation is considerable and introduces an error which has been one of the principal objections to the thermo-electro pyrometer. The so-called cold end error has been a serious obstacle to the use of the thermo-electric pyrometer, especially on large permanent installations. In the above instrument this has been practically eliminated by means of the zero adjuster and cold end water jackets.

Before the zero adjuster was developed it was necessary, in order to obtain the correct temperature, to add or subtract from the meter reading the difference between the cold end temperature and the zero setting. With the zero adjuster it is only necessary to reset the meter zero or starting point to agree with the thermo-couple cold end temperature, whereupon the meter will automatically read the correct temperature of the hot end.

When the pyrometer equipment consists simply of a meter and a single thermo-couple, the zero adjuster alone is sufficient to correct for the thermo-couple cold end temperature variations. It is seldom that the cold end temperature is subject to rapid variations and it is thus a very simple matter to occasionally reset the meter zero in agreement with the cold end temperature, thereby obtaining correct temperature indications by the meter.

It is when the installation consists of a number of thermo-couples all connected through a selective switch to the same meter and when the various couples are subject to different cold end temperatures that a cold end water jacket is necessary, since it would, of course, be impracticable to reset the meter zero to agree with the cold end of each thermo-couple in turn.

The function of the cold end water jacket is to keep the temperatures of the cold ends of a number of thermo-couples at approximately the same temperature. With this accomplished, but one setting of the meter zero is necessary, regardless of which couple is connected to the meter when the reading is taken. The manner in which the cold end water jacket accomplishes its purpose will be made clear by the following description of the Hoskins cold end water jacket..

This water jacket consists of a coil of seamless steel pipe covered with a layer of heat insulating material. The coil is of sufficient diameter to permit the insertion of the thermo-couple spool. Six or less of these jackets are connected in series to a water line having sufficient pressure to keep a continuous flow of water through the system. A thermometer is inserted in the pipe before the first jacket and another after the last one of the series. These thermometers indicate the temperatures of the water as it enters and leaves the jackets and the mean of the two temperatures is taken as the temperature at which to set the zero. As the increase in the water temperature is never over 10°, the maximum error would only be 5°, which is sufficiently accurate for practical purposes. With this system it is seldom necessary to adjust the meter zero more than once or twice a day.

Protecting Tubes.—The choice and use of the proper protecting tubes has much to do with the success of the thermo-electric pyrometer. At high temperatures the elements of the couple become somewhat soft and susceptible to the action of gases. By protecting the couple with a tube of the right type it is possible to prevent or delay these injurious effects and lengthen the life of the thermo-couple elements. The protecting tube also protects the couple against mechanical injuries.

Quite contrary to the general impression, it is not oxidizing but reducing gases which seem to have the most detrimental effect on the thermo-couples. An oxidizing gas causes a gradual deterioration of the couple which can be observed and which permits the user to provide another thermo-couple before it breaks down. But with reducing gas, the action may be sudden and local and frequently causes a couple in good condition to break shortly after being put in the heat. It is this fact in connection with the wrong choice or entire lack of tubes that has caused much unnecessary dissatisfaction with thermo-electric pyrometers.

For temperatures up to 1,200° F. a good steel tube will give excellent satisfaction, in ordinary furnace gases. From 1,200 to 2,000° F. a nickel chromium protecting tube should be used. However, above 2,000° they are not very satisfactory and a very heavy seamless steel tube should be used.

Calibration.—In plants where a large number of pyrometers are used it is advisable to have an easy and dependable way by which to periodically check the accuracy of the various thermo-couples and meters. The most satisfactory way to do this is to use an accurate check pyrometer with which the installed pyrometers can be compared under service conditions.

The method of checking is to place the thermo-couple of the check pyrometer in the same protecting tube with the service couple, being careful to see that both couples are inserted to the full depth of the protecting tube. By then comparing the readings of the two meters the accuracy of the service pyrometer can be determined. In order that there may be sufficient room for both the service and the check couples, all protecting tubes should have an inside diameter of at least ¾ inch.

The type of pyrometer best adapted and most used for checking is the portable instrument. They should, of course, be very accurate. In order that it may be kept in this condition it should be used for no other purpose than checking and should be calibrated occasionally.

For low reading pyrometers the calibration may be done by placing the thermo-couple in a heated oil bath and comparing the readings of the meter with those of a high-grade mercury thermometer, having a range up to 150° C. (300° F.). The vessel for holding the oil should be approximately 6 in. deep by 4 to 6 in. in diam., and may be heated by a gas burner or electric hot-plate. Constant stirring of the oil should be done to insure a uniform temperature throughout. Any oil having a high flash point, or some of the waxes such as paraffine, beeswax, etc., may be used.

For calibrating pyrometers for temperatures above red heat, the welded or hot end of the thermo-couple should be covered with a tight winding of No. 14 or No. 16 B. & S. gauge standard melting point wire. The

couple should then be inserted in a tube furnace similar to the electric furnace shown in Fig. 1, with the welded end of the couple approximately in the centre of the furnace. The furnace should be up to heat before inserting the couple and should be kept at a temperature approximately 100° F. higher than the melting point of the calibrating wire. The pointer of the meter will then move up the scale with a gradually decreasing speed until the calibrating wire begins to melt, when the pointer of the meter will come to rest. After the calibrating wire has melted the pointer will again move upward. Pure copper wire, under oxidizing conditions, melts at 1,065° C. (1,949° F.) and pure zinc wire at 419° C. (786° F.). In order to have a strictly oxidizing atmosphere, an open end electric furnace should be used for calibrating work.

In using this method of calibration, care should be taken not to have the furnace temperature too far above the melting point of the calibrating wire, or the pointer will move so rapidly that the melting will be of such short duration that the holding point may be missed.

A very satisfactory way of calibrating pyrometers is by using the freezing points of melted salts as follows:

Pure common salt, Na Cl., is melted in a pure Acheson graphite crucible in an electric furnace. When the salt has been raised to a temperature of 100 or 200° F. above its melting point, the bare welded end of the thermo-couple is inserted in it to a depth of from 2 to 3 in. The crucible is then removed from the furnace and allowed to cool. The pointer on the meter will drop gradually until the salt begins to freeze, when it will stop until the salt is frozen. The freezing point of pure salt may be taken at 800° C. (1,472° F.). Before further use, the couple end should be washed clean in hot water to remove all traces of the salt, otherwise the couple will deteriorate rapidly, especially when heated considerably above the melting point of salt in an open furnace.

When calibrating pyrometers, care should be taken to see that the zero setting of the meter is in agreement with the cold end of the couple.

When the pyrometer is found to be reading too high the correction is made by increasing the adjusting resistance; and if reading too low, the resistance is decreased. The adjusting resistance is No. 26 B. & S. gauge wire of low temperature coefficient. In changing this resistance the connections should always be carefully soldered and the different turns insulated from one another.

Changing the resistance on the couple spool should not be attempted by the user unless he thoroughly understands, and has had some experience at, such work.

The following table gives the latest available data by the Bureau of Standards on certain substances which may be used for calibrating pyrometers:

Water boils at	100° C.	(212° F.)
Tin freezes at	232° C.	(450° F.)
Zinc freezes at	419° C.	(786° F.)
Common salt freezes at	800° C..	(1472° F.)
Copper, in oxidizing atmosphere, freezes at	1065° C.	(1949° F.)

Among the orders recently placed with English firms, figures an oil tank steamer of about 3,800 tons gross and about 365 feet in length for the Australian Government, to be built by Swan, Hunter and Wigham Richardson.

It is reported from Fredericton, N.B., that the residents of Granite Hill, Bear Island, Upper Queensbury and the districts on the other side of the St. John River in that vicinity are moving again to have a steel highway bridge built across the river at Bear Island.

THE CLAYWORKING INDUSTRY IN NEW BRUNSWICK.

In a report by Joseph Keele on the clay and shale deposits of New Brunswick the geological survey branch of the Department of Mines, Ottawa, has just published some very interesting information. The report covers work done in that province by the Geological Survey during 1911 and 1912. A chapter is devoted to the extent at present of the clay industry, and from it we make the following extracts:—

Up to the present time the clay deposits of New Brunswick have only been developed to a very limited extent.

Wooden construction prevails, to the exclusion of almost all other kinds, except in the business portions of the cities and towns, because lumber has hitherto been plentiful and cheap in the province.

The danger from extensive fires is always present when wooden construction is so freely used in closely-built communities. This was evident in the total destruction of the town of Campbellton by fire during the summer of 1910. Since then, the demand for structural clay wares is increasing, but they are not yet used as largely as they might be, because everything except common brick has to be imported.

New Brunswick possesses in its Carboniferous rocks, certain shale beds, adapted for making those higher grades of clay wares which cannot be produced in the Provinces of Quebec or Ontario, where these raw materials are absent. Clayworkers will probably find it to their advantage to locate works for the production of materials, not only for home consumption, but also for export.

Proximity to markets, although desirable, is not so essential to manufacturers of the higher grades of clay wares, such as face bricks, paving bricks, sewer-pipe, electrical conduits, fireproofing, etc., as these materials are frequently transported for long distances. A plant equipped for a large output of common brick can only be maintained close to cities, where the demand for them is constant during the greater part of the year. These plants frequently represent a considerable expenditure of capital, being furnished with artificial driers, continuous kilns, and machinery driven by steam or electric power. The surface clays can be worked in a primitive manner, with a small outlay of capital, to suit the demands of small towns or rural communities. Such plants are able to maintain their position, because the price of common brick would not pay the cost of carriage from large centres where their manufacture is carried on more scientifically.

When the need for underdraining the cultivated areas in the Province becomes more generally known, these clays will have a much wider application. Drain tile can be made from any of the surface clays. Tile are made from stiff mud, usually by an auger machine having a circular die, although different styles of plunger machines and also hand presses are used in their manufacture. They are made in sizes varying in diameter from 2 inches to 3 feet. Any means of drying and burning may be used with the smaller sizes, but the larger sizes require considerable care to prevent cracking. Contrary to the popular notion, it is not necessary for drain tile to be porous, so that they should be hard burned. Besides sufficient hardness, the important requirements for drain tile are straightness, uniformity of diameter, and smoothness of ends.

The only pottery in operation in the province is located at St. John. It is owned by J. W. Foley and Company, who manufacture butter crocks, teapots, jars, and flower pots. Most of the raw material is imported from the State of New Jersey.

The following details concerning the clay-working industry of the present time in New Brunswick are briefly given.

Fredericton.—M. Ryan and Son are the only brick manufacturers at this city. The material used is a surface clay, of the estuarine type, somewhat similar in character to that worked in the Annapolis and Shubenacadie valleys of Nova Scotia. The clay is moulded in a soft mud machine, without any preliminary pugging, but nevertheless makes a good grade of brick. The freshly moulded bricks are hacked out on the ground to dry in the air, but since Mr. Keele's visit, Mr. Ryan has installed a steam drier. Burning is done in a patent double chambered downdraft kiln, each half having a capacity of 90,000 bricks. The brick settles 12 inches in 31 courses during the burning.

St. John.—Two brickyards are in operation in the vicinity of this city. The clays used are all similar, being evidently remnants of marine or estuarine deposits laid down at a slight elevation above present sea-level. The clays are smooth and plastic, and free from pebbles. Any pebbles found in the finished bricks have probably come from gravels overlying the clays. The brickyard of Mr. John Lee is located on Courtney Bay at the Little river. The material used here is a tough, reddish brown clay and worked to a depth of 6 or 7 feet below the surface. The brick clay rests on a very hummocky boulder drift, which crops out in a few places in the bottom of the pit. The clay, after being broken down from the bank, is dumped into soak pits along with some sand, and kept there for a day or so before going to the machine. Sand-moulded or, soft mud bricks, some re-pressed bricks for facing buildings, and field drain tile are manufactured. The freshly moulded bricks are placed on covered pallet racks and air dried. There are two down-draft kilns, two updraft case kilns, and one scove kiln. The output is 25,000 bricks per day during the season, which are mostly sold in St. John.

St. Stephen.—There are two brick yards in operation near this town, making soft mud brick and drain tile. The material used is taken from a terrace of marine clay which occurs along the valley of the St. Croix river. Mr. John Laming has made bricks here during the last 31 years. He uses a small stiff mud machine for making wire-cut brick for facing, and for drain tile. He also makes soft mud bricks, which form the greater part of his output. The demand for drain tile is intermittent; these are only made to order, and not stocked. The principal object of interest is the tiles with which the building is roofed. These tiles were made by Mr. Laming, 22 years ago, from the clay in his own pit. These tiles are S-shaped, and although not hard burned, are still quite intact for the most part.

Sussex.—The brickyard operated by Mr. John Heffer is situated a few miles north-west of Sussex. The material used is a stiff, reddish clay, from 3 to 10 feet in thickness, overlying boulder clay. A stiff mud machine driven by horse-power is used. The bricks are hacked out on the open ground to dry, and afterwards burned in a scove kiln. The burned bricks contain some scattered, small pebbles and clay lumps, showing the need of passing the clay through rolls, or through a long pug mill, to prepare the clay for the machine. As the clay is becoming too thin for working at this locality, the plant will shortly be moved to a fresh clay deposit in the neighborhood.

Moncton.—The brickworks are located at Lewisville, 2 miles from Moncton. The material made is a glacial clay situated almost at tide level, and underlain by boulder clay. The maximum depth of the clay is 7 feet. This plant is equipped with a stiff mud machine and steam driers. The burning is done in scove kilns. The brick clay also occurs at various points around the city of Moncton, but is worked only at this locality at present.

Chatham.—There are two brick plants in the neighborhood of Chatham, owned by the W.S. Loggie Company. The plant at Nappan river uses a stratified, reddish clay, about 12 feet deep, lying on bed-rock, to which is added about 10 per cent. of sand. Sand-moulded bricks only are made; they are dried on pallet rocks, and burned in scove kilns. The bricks are set 36 courses high in the kiln, and the fuel used is dry spruce and tamarack. The output is hauled in wagons to the railway, and shipped principally to Campbellton. The working season lasts from the middle of May to December. An excellent deep red, hard, building brick is produced at these works.

The plant at Nelson is worked in a similar manner, and produces common brick of a quality very much like those at Nappan. This plant is better situated for transportation, as the bricks have only to be hauled over the bridge across the Miramichi river, to the railway station on the north bank.

On April 15, a delegation of 1,000 gathered at Ottawa, 700 of whom were from Montreal, and formed a permanent organization, whose purpose will be to promote the construction of the Georgian Bay Canal and furnish all necessary information for the recently appointed Government commission on the project; and to present to the Government arguments in favor of the immediate start of construction of the waterway.

The preliminary report on mineral production in Canada in 1913 shows a total value of production amounting to $144,031,047, an increase of 6.65 per cent. over the previous year, representing an average production per capita of $18.57, as against $18.27 in 1912 and $14.93 in 1910. The amount of coal produced was valued at $36,250,311, an increase of $[illegible]. The gold produced amounted to a value of $16,216,131, an increase of $3,567,337. The value of pig iron produced was $16,540,012, an increase of $1,989,013. There was a decline in the production of copper from a value of $12,718,548 in 1912 to $11,753,440 in 1913, and a decline in silver production from $19,440,105 to $18,084,012. Cement production increased from $9,106,556 in 1912 to $11,227,284 in 1913.

During the coming summer, a new railroad, thousands of miles in length, will be opened to traffic in Central Asia. It is a line which, linked to the existing Trans-Siberian Railroad at Krasnoyarak, crosses through the northern part of the province of Irkutsk, north of the Baikal Lake, through Eastern Siberia, and then through the Amur province, northward to the Amur river, to Kakhaborovsk, where it joins the already existing line that runs due south to Vladivostok. The surveys for this new line were already begun while the Russo-Japanese peace negotiations were in progress at Portsmouth, N.H., in 1905. It is built entirely on Russian territory; and, since the province of Eastern Siberia, and of the Amur, lying north of Manchuria, are perhaps more rich in minerals than any other portion of the world, the line bids fair to prove of the utmost economic importance. Much of the line has been laid through primeval forest, and through jungles where man had never set foot before, and where the temperature ranges from tropical heat in summer to 80½ below zero in winter; where the men had frequently to work for days and months standing almost thigh-deep in icy marsh. $2,050,000,000 have already been voted by the Duma for the construction of the road. Whether it will be sufficient or not to cover its cost is not known. It is intended that this new main line is to constitute the main trunk of a vast network of subsidiary lines. It will connect Moscow, over an all-Russian route, with the Czar's great stronghold on the Pacific, Vladivostok.

TRAVELLING CONCRETE PLANT.

A NOVEL concrete mixing plant with elevator tower and distributing chute is described in the "Canal Record" of Panama. It is being used for mixing and placing the concrete in the caisson shells and superstructures of the quay wall and pier now under construction at the Balboa terminals. Four units of the type are in use. The system has advantages of convenience, speed, and reduced labor cost.

Each unit consists of a hoisting engine, of approximately 20 horse-power, steamdriven; a ½-cubic yard portable mixer; an elevator for raising the concrete so that it can be distributed from a hopper by gravity; and a jointed distributing chute, for placing the concrete from the hopper. All of these items are mounted on a single flat car, resting on a 5-foot gauge track. The plant is advanced along the track with the progress of the placing. The sand, rock, and cement for the concrete may be handled to the mixer direct from cars coupled to the flat car in the rear, or from stock piles alongside the site of operations. In either case, they are carried to the mixer in wheelbarrows, over suitable staging.

The hoisting engine boiler furnishes steam for the mixer, and, by cables running over sheaves at the top of the elevator tower, raises and lowers the elevator car.

The elevator is a hollow timber framework, 4½ by 6 feet in plan. In the unit of which the side and front views are shown herewith, the tower rises to a height of 41 feet 3 inches above the deck line; in this type, the distributing chute is 52 feet long, with a distributing radius of 48 feet. In two other units of similar general design, the chute is longer, having a distributing radius of 78 feet. The elevation of the tower is determined by the requirements of distributing the concrete by gravity. In each case, the tower is braced by timber outriggers.

The elevator car is the body of an ordinary ½-yard Decauville dump car, mounted on trunnions. At an elevation determined by the length of the chute, it dumps automatically into a hopper which rests on a projection on the front side of the elevator shaft. The hopper is six by six feet in plan at its top, converging into juncture with the distributing chute. It has a capacity of about one cubic yard.

The distributing chute is of 14-inch steel pipe. It is in two sections of equal length, connected by means of a swivel joint. The upper section is known as the swivel arm, and the lower section as the nozzle arm. The upper section is connected with the hopper discharge by a swivel joint, and can swing to either side to a position at right angles with the axis of the flat car. The nozzle arm, swinging under the upper section, can describe a circle, the centre of which is the joint between the two sections. This combination of motions allows the mouth of the chute to be placed over any point in the semicircle described by swinging the chute with both sections extended in the same plane.

The method of supporting the chute is of especial interest. Both sections of the chute are supported by means of a pivoted latticework boom, projecting outward and upward from the front of the base of the elevator tower. The timbers of the boom pass on both sides of the upper section of the chute, allowing its support to be effected by the cross pieces. In addition, the boom passes far enough beyond the upper section to allow vertical guys to be attached to the intermediate joint, and slanting guys to be extended to the end of the nozzle arm. This does away with extraneous supports for the nozzle arm, and with the services of laborers in carrying it from point to point.

The system allows the mixing and placing of from 180 to 200 cubic yards of concrete per day from the ½-yard mixer. The arrangement of the chute allows the placing of concrete all over the semicircle in front of the mixer without the use of men with wheelbarrows, operating on runways laid over the reinforcement. These features are especially desirable in the pier construction, where it is important to complete a section, including a main girder and extending half-way to the girders on either side, in one day, in order that the concrete may harden in a complete unit.

In the new pier No. 1, each section is 29 feet 6 inches long by 75 feet 11 inches wide, and contains 191 cubic yards of concrete. One mixing unit will complete a section a day; but in case of breakdown, another unit can be withdrawn from caisson work and sent to supplement the placing for the pier. Each outfit is practically as portable as a wrecking crane.

The force for each unit consists of approximately 30 silver employees in charge of a white foreman. Twenty-five men are engaged in wheeling materials from cars or stock piles and supplying the mixer; one man is in charge of the mixer; one runs the hoisting engine; and three are out at the end of the chute distributing the concrete into the forms. This arrangement makes the labor cost very low.

The report of the Timiskaming and Northern Ontario Railway Commission for the year ended October 31st, 1913, shows a total mileage of the railway in operation at the end of that year amounting to 432.77, including 252.8 miles of main line, 80.64 miles of branch lines, and 99.33 miles of yards and sidings.

It has been decided to construct dams along the creek at Caron, Alta., for the purpose of protecting the infiltration pipe gallery and to increase the storage capacity of the Caron head works. Thev will be built of concrete and will be finished this summer.

In the two years, 1912-13, in British Columbia, the demand for structural materials—stone, cement, clay products, etc.—has not been so great latterly as in 1910 and 1911, so the value of the output of this class of non-metallic minerals was probably lower in 1913, and in the absence of data on which to base calculations no definite statement can be made. The marble-quarry in the Ainsworth Mining Division was worked and marble was shipped from it. Near Victoria, on Saanich Arm, a second cement manufactory was started, and near Princeton a beginning to produce cement was also made, but in neither case was a large output made. The Vancouver-Portland Cement works at Tod Inlet continued to make an important production. The destruction by fire of the large pottery works at Victoria has added to the decrease in production of structural materials, but this loss in output is only temporary, the erection and equipment of new works having been provided for.

The following table shows the mileage of the various classes of work carried out under Street Improvement By-laws and General Revenue for 1913 at Vancouver, B.C.:—

	Miles.
Clearing and rough-grading streets	22.134
Ditching and crowning streets	4.516
Clearing and rough-grading boulevards	17.822
Clearing and rough-grading lanes	5.250
Grading streets	12.688
Grading boulevards	15.155
Grading lanes	3.000
Rocking streets	5.148
Rocking lanes	2.110
Extending rocking to curbs	1.228
Resurfacing streets	4.405
Plank roadways, streets	22.941
Plank roadways, lanes	12.107
Three plank walks	32.460
Bulkheads	.825
Culverts and box-drains	.664

Coast to Coast

Moose Jaw, Sask.—The City Council of Moose Jaw has voted down the recommendation of the city commissioners that drilling for gas at the city test well be discontinued.

Moose Jaw, Sask.—The new ten-circuit automatic storage battery switchboard, which will be installed at the Central Fire Hall, Moose Jaw, during the next month, will represent an outlay of $6,000.

Toronto, Ont.—The first through train has traversed the new C.N.R. line between Quebec and Toronto, arriving in Toronto on May 1; and the entire road has been pronounced satisfactory by the officials.

Winnipeg, Man.—Recently at Winnipeg a statement was published to the effect that the earnings on all Canadian railways during 1913 amounted, broadly, to $200,000,000 according to figures just compiled. These figures include all the subsidiary lines, and other affiliations of any nature.

Port Mann, B.C.—Plans are being perfected by the C.N.R. for extensive terminal facilities at Port Mann, B.C., its Pacific freight terminus and ocean port. Plans passed upon this year by the management call for yard trackage to store and manipulate 10,000 freight cars and 1,000 passenger coaches.

Vancouver, B.C.—The Burrard street bridge, a part of the C.P.R. terminal improvement scheme at Vancouver, has been completed with the exception of the ramp, which will lead from the waterfront end of the viaduct to the dock level; and this cannot be built until the old immigration sheds have been removed

Bassano, Alta.—The great irrigation dam of the C.P.R. at Bassano, Alta., was formally opened on April 26 by Sir Thomas Shaughnessy, president of the company. It is claimed that the Bassano dam is the largest in the world, and is even longer than the famous Assouan dam of Egypt. The water it contains will cover 14,000 acres to a depth of one foot.

Toronto, Ont.—Owing to changes which have been effected in the Power Commission Act by the Ontario Legislature, Ontario townships will now be able to make contracts for hydro-electric power without submitting the matter to a vote of the ratepayers. All that is required is a petition from residents of the township; and when this is submitted and considered, the council may enter into a contract with the commission.

Guelph, Ont.—The annual report of the Light and Heat Commission of Guelph shows very satisfactory returns; and though the rates were reduced 5 per cent. at the beginning of the year for power, residential and commercial lighting, with the increase of business that this reduction has effected, it is expected to make a further decrease in rates at the end of the year or earlier. The report shows that over twice as many electric services were installed in 1913 than in the previous year.

Regina, Sask.—During 1914, over $1,500,000 will be expended on roads and road improvement in Saskatchewan, according to the decision of the highways commission of the provincial government. Of this outlay, $500,000 is to be expended in bridge work, the largest undertaking of the bridge department this year probably being the completion of the high-level bridge at Saskatoon, which is to be completed by December 31. Approximately $100,000 is to be expended on small concrete and steel bridges.

Toronto, Ont.—Main estimates have been tabled in the Ontario Legislature for 1914-15 totalling $9,810,749.66, while those tabled for 1913-14 were $9,524,387. Of this year's amount $8,811,749.66 is to be voted to meet current expenditure, while $849,000 will be set aside for capital expenditures, $150,000 being provided for other purposes. The current expenditures for 1913-14 were nearly half a million lower than for this session, being $8,353,387; but the amount provided for capital expenditure a year ago was considerably larger than the vote now asked for, running up to $1,042,000.

Montreal, Que.—The construction program of the Montreal harbor commissioners has been resumed. Dredging has been started on the South Shore Channel, and an endeavor will be made to have the channel completed before the closing of navigation. Also a start has been made at tearing down the old Victoria pier, work is being carried out at the new drydock, the widening of the ship channel in the harbor is to be continued, the construction of sheds at sections 23 and 24 is being rushed, while the addition to the commissioners' elevator is practically completed.

Saskatoon, Sask.—The total contract for the completion of the students' residence of the University of Saskatchewan, for which contracts were awarded last week, will entail an approximate expenditure of $216,000 for Section A; and, including Sections B and C, the total cost will be $265,000. In addition to the residence construction, the new Physics Laboratory will be constructed this year at a cost of between $120,000 and $150,000, and will constitute the first unit of the new science block. Also this year the foundation work for the proposed chemistry building will be undertaken.

Vancouver, B.C.—According to the opinion of Engineer Breckon of Vancouver, the laying of pipe across the First Narrows, including the hauling of the second main already started, will entail an additional expense of $6,000 to $10,000, or about $70,000 for the rest of the work on the connecting of the Point Grey pipe with Little Mountain reservoir. Of this, $45,000 will be needed for the crossing of False Creek and the few special valves along the route for fire protection. At the end of March the expenditure on the pipe line was $430,738, so that the total cost will be more than $500,000.

Edmonton, Alta.—It has been reported at Edmonton that $500,000 has been received by the Provincial government of Alberta to be used for the building of western Canadian railway lines. It is stated by the secretary of railways that it is for the Canadian Northern Western, a subsidiary company of the Canadian Northern. This amount is the first instalment of $6,000,000, for which bonds were placed on the market last spring. Moreover, according to the railways branch, over $11,000,000 is available for railway construction in Alberta this year, on railways guaranteed by the Provincial Government; and it is estimated that 700 miles of railway should be constructed during the present year.

Toronto, Ont.—The C.P.R. bridge over the Don River, 9 miles from the Union Station, has been completed by the Walkerville Bridge Company. The contractors for the cement work were Dickenson and Burns. The new bridge is much stronger and heavier than the old bridge, alongside of which it has been erected. It is about 1,000 feet long, weighs over 1,200 tons, is 120 feet above the level of the River Don, and is supported by 9 steel towers and 2 concrete abutments. Two of the towers provide openings for roadways, one on either side of the river; while the largest tower spans the C.N.R. line to Winnipeg, 80 feet below the level of the bridge. The completion of the bridge allows now of the completion of the small portion of work yet undone on double-tracking the line from Agincourt to Leaside. When the other new bridge over the west Don has been finished, the two old bridges over the main and west Don rivers will be strengthened and improved so as to afford a complete double track from Streetsville in the west to Agincourt in the east.

Ottawa, Ont.—It has been announced recently at Ottawa that, with a view to enabling the engineers of the government to work [illegible] scheme of power development on the main Saskatchewan river, and at the same time not to impair future navigation, it has been considered advisable to have a thorough examination made on the ground by the hydraulic engineer of the water power branch this coming summer. In the meantime, Hon. W. J. Roche, minister of the interior, has directed that all available Dominion lands, contiguous to this power site, be removed from any disposition whatever, and be dealt with only under the Dominion water-power regulations. During the past two seasons the engineers of the Dominion water power department have investigated the possibilities of this river in the vicinity of Grand Rapids, where the river disgorges into Lake Manitoba; and, while incomplete, a photographic survey of the whole region has been made.

Fort William, Ont.—The mayor of Fort William has outlined to the city council an agreement which will doubtless be entered into by the city and C.P.R. company. It is to the effect that the city and the railway company shall jointly build a new subway with cement piers and abutments and steel superstructure at McVicar street, with a revetment wall that would give an additional width of 7 feet of roadway from the subways to the local sheds, and afford a double roadway and two sidewalks through the subway; that the city dock shall be extended 50 feet to the harbor line; that the company shall give the city 200 feet of frontage down the river from the present city dock; that the city shall give the company surface rights on McTavish street between the railway tracks and the river, reserving the right for an overhead right-of-way for access to a bridge, whenever it should be necessary; and that the city shall pave and maintain the Syndicate avenue subway. This basis of agreement has been authorized by council and forwarded to the company.

Toronto, Ont.—Recently in the Ontario Legislature, while outlining the expenditures for which a vote of $5,000,000 in the supplementary estimates has been required by the Hydro-Electric Commission, the Hon. Adam Beck stated that the question of the commission entering upon the work of actually producing power would sooner or later have to be solved. The Ontario Power Company is now supplying power to the Commission, and wants to have the contract reopened. It desires permission to utilize the remainder of the available water at Niagara Falls, which would bring its maximum development to 106,000 horse-power. If this is done it proposes to relinquish rights to export 50 per cent. of the power developed to the United States, and to leave 60 per cent. for use by the Hydro-Electric at $12 per h.p. The Commission is paying $9 per h.p. at present, and it is not thought that the $12 rate is low enough. If cheaper power cannot be procured the Commission may have to install its own plants. Two sites are available, one below the whirlpool, and the other the spillway of the Welland Canal, if power rights to this can be secured from the Dominion Government.

Esquimalt, B.C.—The following particulars have been published concerning the drydock to be constructed by the Dominion Government at Esquimalt. The north side of Lang's Cove has been chosen as the dock's site. Its dimensions will be as follows: length from caisson stop to head wall, 1,150 feet; width of entrance, 120 feet; depth on sill at ordinary high water spring tides, 40 feet; width at coping of dock walls, 144 feet. It will be divided, as stated, into two parts of 650 and 500 feet, respectively, each part being closed by a ship steel caisson. The dock will be emptied by [illegible] centrifugal pumps, each having a capacity of 60,000 [illegible] per minute. The pumps and other machinery will be run by electric power generated by the dock power plant. After the rock excavation has been finished, the walls will be constructed. For these concrete will be used, with granite copings and alters. All keel and bilge blocks will rest on granite stripe extending the full length of the dock, and granite will be used for caisson stops. On the south side a basin will be formed; and the structure around this will be built of reinforced concrete piles. In addition to the drydock work proper, a large area of land must be reclaimed, and an extensive frontage of wharves, for which reinforced concrete will be used, must be constructed.

Medicine Hat, Alta.—Contracts have just been awarded by the Southern Alberta Land Company, of Medicine Hat, for the removal of some 560,000 cubic yards of earth, for the purpose of carrying to completion the first stages of the work and the placing of about 30,000 acres of land under water by next spring. All contracts are to be completed by October 15, 1914, and the total cost will be about $80,000, running somewhat under the engineers' estimates. In about two weeks another contract will be let for 150,000 more cubic yards of excavation, part being at the Little Bow river and the balance near the head of the main canal near Gleichen. The contracts let this week are for some 5 miles of the main ditch, leading from the new reservoir to the Little Bow river, which is some 15 miles from the main reservoir, known as Lake McGregor—this main canal to be 44 feet wide at the bottom, 78 feet across the top, and to hold 8 feet of water; and for the laterals, to provide for the direct watering of the 30,000 acres of land next spring. On April 1st occurred the completion of the new dam at the intake on the Little Bow river, a piece of work that represents a cost of about $70,000. By July 1st or sooner, water will be turned into the main canal, the reservoir holding about 30,000 feet of water. Thus far the company has expended about $4,500,000 on this enterprise, and it bids fair to be one of the most important in the Canadian West, as the plans call for the irrigation of over 200,000 acres of land.

Victoria, B.C.—Active operations are reported as now in progress by the contracting firm, Messrs. Grant, Smith, and McDonnell, in connection with the building of the two new piers in the greater harbor improvement program. Five large scows have arrived at Vancouver for the purpose of dumping the rubble foundation of 300,000 tons, of which the first 60,000 tons is ready for delivery. The cribs to be built will be 58 in number. Each requires 110 tons of steel work, and when complete will be a ferro-concrete structure weighing 3,500 tons. These will be constructed on a floating drydock which is now at the Bremerton Navy Yard, in Seattle, and which will arrive at Victoria shortly. This drydock has a carrying capacity of 8,000 tons, is 385 feet long, 115 feet wide, and has a depth of 55 feet. When the drydock has been delivered, the construction of cribs will commence at the company's gravel property at Albert Head, where excavations are to be made to provide a slip for the floating dock. The most modern machinery for the removal of the gravel will be installed at a cost of $40,000; and when in operation, the output will be in the neighborhood of 1,800 cubic yards daily. Also, the company proposes opening up and equipping with donkey engines, steam shovels, etc., a rock quarry in the vicinity of Victoria, by means of which the company expects to bring to the site of the piers about 60,000 tons of rubble each month. It is anticipated that the necessary quantity of material will be dumped before next winter is far advanced. When the work is well under way, the contractors will have 12 scows, a dredge scow and a drill boat in operation, the latter to be used in removing rock for excavating underneath the cribs. The contract is to be carried out under the supervision of Mr. J. S. Maclachlan, Dominion Resident Engineer.

NEWS OF THE ENGINEERING SOCIETIES

Brief items relating to the activities of associations for men in engineering and closely allied practice.
THE CANADIAN ENGINEER publishes, on page 90, a directory of such societies and their chief officials.

AMERICAN SOCIETY C.E. CODE OF ETHICS.

The Board of Directors of the American Society of Civil Engineers is placing before the membership the following proposed code of ethics, and is recommending its adoption:—

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the American Society of Civil Engineers:—

(1) To act for his clients in professional matters otherwise than as a faithful agent or trustee, or to accept any remuneration other than his stated charges for services rendered his clients.

(2) To attempt to injure falsely or maliciously, directly or indirectly, the professional reputation, prospects, or business, of another Engineer.

(3) To attempt to supplant another Engineer after definite steps have been taken toward his employment.

(4) To compete with another Engineer for employment on the basis of professional charges, by reducing his usual charges, and in this manner attempting to underbid after being informed of the charges named by another.

(5) To review the work of another Engineer for the same client, except with the knowledge or consent of such Engineer, or unless the connection of such Engineer with the work has been terminated.

(6) To advertise in self-laudatory language, or in any other manner derogatory to the dignity of the profession.

It is noteworthy of observation that the American Society of Mechanical Engineers and the American Institute of Electrical Engineers have both discussed codes that are very similar to each other, the latter having already adopted theirs. The above code, compared with the others, is quite brief and simple, and free of all attempts to lay down general rules of practice that are devoid of ethical bearing.

The draft will be presented to be acted upon by the members at the convention in Baltimore, Md., on June 2nd. The opinion generally expressed is that it will be adopted.

CLUB "SMOKER."

The Engineers' Club of Toronto will hold a smoker in the club rooms on Friday evening, May 8th. The occasion will admit of examination and criticism of the preliminary plans of the proposed new Engineers' Club building.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11-15, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—**To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.**

INTERNATIONAL CONFERENCE ON CITY PLANNING to be held in Toronto, May 25-6-7, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

AMERICAN SOCIETY FOR TESTING MATERIALS. **—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30 to July 4, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.**

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—**Eighth Annual Meeting will be held in Duluth, Minn., on August 20, 21 and 22, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.**

CANADIAN FORESTRY ASSOCIATION.—**Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.**

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—**Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.**

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9-13, 1914. J. E. Pennybacker, Secretary, Colorado Building, Washington, D.C.

PERSONALS.

G. W. BARRETT was recently appointed sewerage engineer for the town of Esquimalt, B.C.

NORMAN HICKS has been appointed engineer to the town of Weston, Ont., and to the Weston Water, Power and Light Company.

G. H. ARCHIBALD, of St. Catharines, has been appointed city engineer of Saskatoon, Sask., to succeed Geo. T. Clark, resigned.

J. L. BUSFIELD, B.Sc., of the Mount Royal Tunnel and Terminal Company, Montreal, has recently been elected associate member of the Institution of Civil Engineers, Great Britain.

C. C. MENDHAM, who has been connected with the outdoor staff in Toronto of the Herbert Morris Crane and Hoist Company, Limited, has now been appointed resident engineer in Berlin for that company.

OBITUARY.

The death occurred at Beamsville, Ont., on May 4th of Senator William Gibson, who for many years took an active part in railway and bridge building in this country. For 22 years he had charge of the construction of masonry work on the Grand Trunk system in Canada. He built the approaches and portals of the Sarnia tunnel and had charge of the doubling of the Victoria Jubilee bridge at Montreal.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21666—April 17—Authorizing C.P.R. to construct spur for J. E. Wilder, Montreal, Que., from point on easterly limit of right-of-way of main line, Farnham Subdivision, in Lot Cadastral No. 70-A, (Civic), Cote des Neiges Ward, city of Montreal.

21667—April 17—Authorizing C.P.R. to construct spur for Goold, Shapley and Muir Co., Limited, Regina, Sask.

21668—April 17—Authorizing C.P.R. to construct, at grade, tracks of spur for city of Moose Jaw across River St., in said city; and to construct, at grade, 2 tracks of wye connection on Main line, Sask. Div., across Manitoba St., and Second Ave., city of Moose Jaw, Sask.

21669—April 15—Authorizing C.P.R. to construct spur for city of Edmonton, Alta.

21670—April 16—Authorizing C.P.R. to reconstruct bridge No. 37.5 on Havelock Subdivision, Ontario.

21671—April 15—Authorizing Esquimalt and Nanaimo Ry. to construct siding for Empire Lumber Co., from a point on Osborne Bay Branch of its Railway, mileage 2.5, Vancouver Island, B.C.

21672—April 18—Approving location Pointe aux Tremble Ry. through town of Montreal East, Que.

21673—April 18—Authorizing Cedars Rapids Mfg. and Power Co. of Montreal to take an additional width for its right-of-way for its transmission line across certain lots in Parishes of St. Joseph de Soulanges and St. Ignace du Coteau du Lac, Province of Quebec.

21674—April 17—Directing that C.P.R. construct spur from point on its railway connecting main line with St. Lawrence and Ottawa Line, leading to Sussex St. freight yards, to and into premises of Dustbane Manufacturing Co., Limited, Tp. of Gloucester, Co. Carleton, Ont. subject to and upon certain conditions.

21675—April 18—Authorizing C.P.R. to construct a rearrangement of sidings for McGregor and McIntyre, Limited, on parcel of land lying north of its tracks and easterly of Shaw Street, North Toronto, Ont.

21676—April 18—Authorizing C.P.R. to construct spur for S. A. Early and Company, Limited, in Subdivision, Lot 26, Block 165, city of Saskatoon, Sask., on Co.'s main line, Sask. Division.

21677—April 18—Authorizing C.N.O.R. to construct across Scarlett Road, between Lots 36 and 37, Cons. 3, F.B., Tp. York, Ont., by means of a structure carrying highway over railway.

21678—April 18—Authorizing C.N.O.R. to construct across Jane St., between Lots 36 and 37, Con. 3, F. B., Tp. York, Ont., by means of structure carrying highway over railway.

21679—April 20—Directing that C.P.R. construct spur into premises of S. A. Hamilton Co., Limited, crossing First Ave West in city of Moose Jaw, Sask., subject to and upon certain conditions.

21680—April 18—Authorizing C.N.R. to construct across twenty-nine (29) highways in Province of Saskatchewan.

21681—April 21—Relieving G.T.R. from providing further protection at crossing of highway immediately east of Pike Creek Flag Station, Tecumseh, Ontario.

21682—April 22—Authorizing G.T.P. Branch Lines Co. and C.P.R. to operate trains over crossing by G.T.P. Branch Lines Co.'s tracks of C.P.R. Calgary to Edmonton Branch, in City of Calgary, Alta., without being brought to a stop.

21683—April 21—Amending Order No. 18032, dated Nov. [illegible] by adding after word "Company" in [illegible] line of operative part of Order, words "[illegible] such cost, [illegible] borne and paid by Village of [illegible]."

21684—April 21—Relieving G.T.R. from providing further protection at crossing of Colborne St., City of London, Ont.

21685—April 20—Authorizing, subject to terms and conditions contained in agreement, C.P.R. to construct highway crossing, at level, over its tracks, at McDougall St., in City of Port Arthur, Ont.

21686—April 22—Suspending "sine die," schedules of G.T.R. and M.C.R.R. in so far as they increase rates now charged on Caustic Soda and Bleaching Powder; disallowing schedule of P.M.R.R. in so far as it increases rates heretofore charged on Caustic Soda and Bleaching Powder; and directing that rates lawfully in force on said commodities immediately prior to effective dates of said schedules be continued in effect until further Order of Board.

21687—April 22—Authorizing, at its own expense, Board of Highway Commissioners for Prov. Sask., to construct highway crossing through station grounds of C.N.R. at Brancepeth siding, N.W. ¼ Sec. 27-46-23, W. 2 M., Saskatchewan.

21688—April 21—Authorizing C.N.R. to construct Seventeen (17) highways in Province of Alberta.

21689—April 25—Amending Order No. 20423, dated Sept. 25th, 1913, by inserting certain words and figures and adding certain clauses.

21690—April 27—Amending Order No. 21513, dated Mar. 16th, 1914, by striking out words, "the cost to be divided equally between the two companies," in 6th and 7th lines of operative part of Order, and substituting words, "the cost to be borne and paid by the Applicant Company."

21691—April 26—Authorizing C.L.O. and W. Ry. (C.P.R.) to take certain lands in town of Bowmanville, Co. Durham, Ont., for purpose of constructing a freight yard, and approaches thereto, subject to and upon certain conditions.

21692—April 23—Authorizing Cedars Rapids Mfg. and Power Co. of Montreal, to take additional width of 25 ft. for right-of-way of its transmission line across Lot 7, Con. 2, Tp. Cornwall, Co. Stormont, Ont., property of James Dingwall.

21693—April 28—Amending Order No. 21476, dated March 11th, 1914, by striking out words, "the bridge over," in recital of Order, and words, "bridge over the said," in operative part of Order.

21694—April 21—Relieving C.P.R. from speed limitation of fifteen miles an hour over railway between mileage 0 and 41, Golden to Spillimacheen, B.C.

21695—April 28—Authorizing C.P.R. to operate over Two bridges, namely, No. 15.6, Alta. Div., Lethbridge Sub. Div., and No. 91.1, Alta. Div., Lethbridge Sub division, Alta.

21696—April 27—Dismission complaint of Milton Pressed Brick Co., Ltd., of Milton, Ont., against action of C.P.R., in holding up construction work on their double tracking between Toronto and Guelph Jct., Ontario.

21697—April 28—Authorizing Kettle Valley Ry., to construct ,at grade, its ballast pit spur across highway between

21698—April 29—Authorizing C.N.R. to construct spur for P. O. Dwyer Co. across Elm Ave., through Blocks 112 and 113, Parkdale, Edmonton, Alberta.

21699—April 29—Authorizing G.T.R. to construct certain extensions to branch line, or siding, and spur therefrom, into premises of Maple Sand, Gravel and Brick Co., Ltd., Tp. Vaughan, Co. York, Ontario.

21700—April 29—Authorizing G.T.R. to construct siding into premises of Toronto Brick Co., Ltd., Tp. Scarboro, Co. York, Ont., near York Station.

21701—April 29—Authorizing Alberta Central Ry. to construct, at grade, its ballast pit spur across highway between N.E. ¼ Sec. 8 and N.W. ¼ Sec. 9-39-3, W. 5 M., and highway between N.E. ¼ of Sec. 8 and S.E. ¼ Sec. 17-39-3, W. 5 M., Alta., at mileage 34 west of Red Deer.

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A weekly paper for engineers and engineering-contractors

NOTABLE RAILWAY CROSSING IN NEW BRUNSWICK

SAINT JOHN & QUEBEC RAILWAY CROSSING OVER THE CANADIAN PACIFIC RAILWAY—INTERESTING RETAINING WALL WITH COUNTERFORTS—GENERAL NOTES ON CONSTRUCTION.

By S. B. WASS, A.M. Can. Soc. C.E.
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IN the location of the Saint John & Quebec Ry. it was necessary to cross the Canadian Pacific Ry. branch from McAdam Junction to Woodstock, N.B., in the vicinity of Woodstock. The latter railway runs along a slope parallel to the River St. John at about the grade base of rail of the Saint John & Quebec Ry. was required, and a through plate girder with the floor beams and stringers set on the bottom flange of the main girders was used. After a study of the conditions, the ground plan shown in Fig. 1 was adopted as that most suitable.

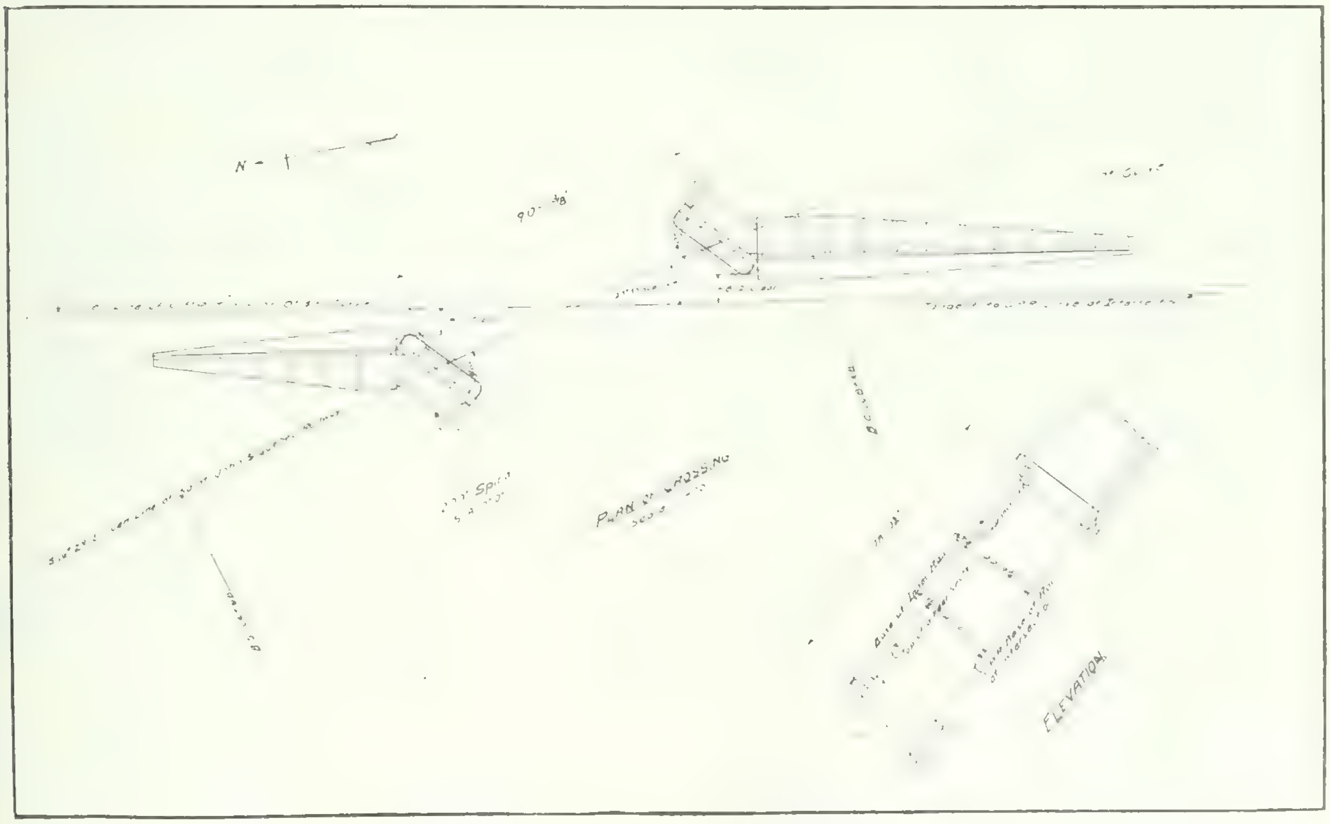

Fig. 1.—General Plan and Elevation of Crossing, Showing Alignment of Tracks.

of the natural ground. As there was no large cutting or embankment convenient for use, it was necessary to construct an embankment on the lower side of the Canadian Pacific Ry. tracks, for the support of the new road. To keep this as small as possible, the angle of crossing between the two roads was made very acute. That the grade of the embankment be kept as low as possible, the minimum distance between the bottom of the steel and the

In making these calculations the standard plans of abutments and gravity wing walls were used.

The design of the masonry for this structure was quite important and more especially the wing or retaining walls, one on each side of the Canadian Pacific Railway.

Design of Wing Retaining Walls.—As experience rather than theory is the necessary guide in building walls, and although theory would lead us to build a much thinner

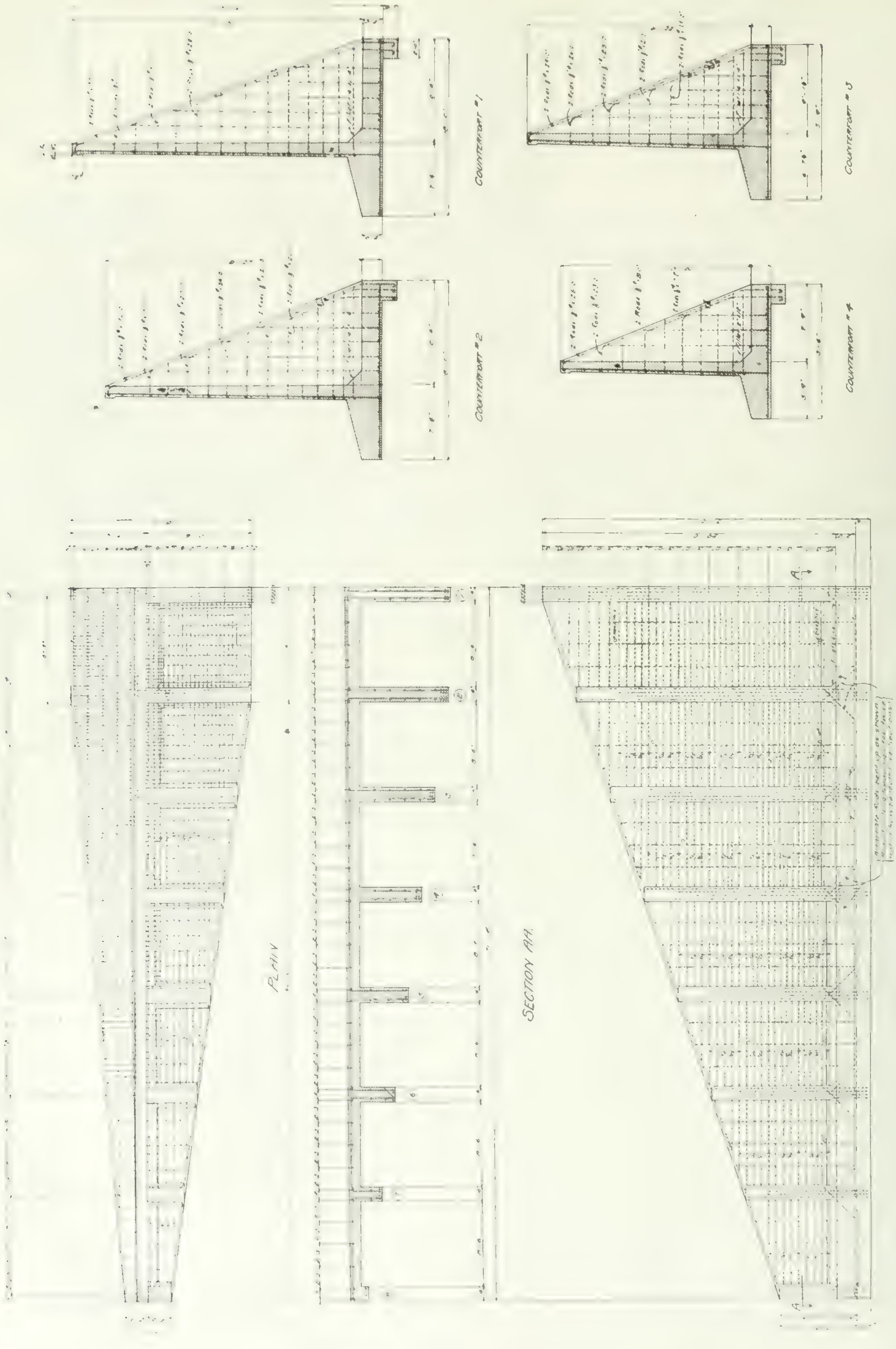

Fig. 2.—Details of the north wall, showing plan, elevation and sections of four of the eight counterforts.

wall, it is the practice of engineers to make the width of the base of a retaining wall 0.35 to 0.45 of the height, and in some cases where there is an additional load due to surcharge of earth, street or railway traffic, walls have been built with bases as wide as 0.5 of their height.

In the case under consideration the foundation was of stiff grayish-brown clay or hard pan, with some boulders and small stones mixed among it and which could be well drained, so was considered sufficiently good support. The embankment which the wall was to retain would be made of train fill material hauled on cars from the ballast pit and dumped from a temporary trestle. As will be seen by reference to Fig. 1, the upper portion of the wall would extend to the elevation of base of rail and would be subjected to the live load on the track in addition to the embankment. From this point to the lower end of the wall the embankment lies at natural slope to elevation of grade. It was, therefore, assumed that the whole wall had a surcharged load and that a gravity wall should have a thickness at its base of 0.45 feet of its height. A wall 1.5 feet thick on top and increasing one foot in thickness for each 2.25 feet in height will give the required base. It became evident for several reasons that a reinforced concrete wall would be better suited to the conditions than a gravity wall:

(1) The unit pressure on the foundation at the toe of the wall would be reduced by the use of a wider base, which could be easily accomplished in the reinforced wall, which was actually made 18.0 feet wide for the highest part of the wall, while that for the gravity wall is 13.63 feet.

(2) The vibration due to the traffic on the C.P.R. track, which lies within eight or ten feet of the wall, would be better resisted by a reinforced structure than by one of plain concrete.

(3) The cost of the structure could be reduced.

Reinforced concrete retaining walls divide themselves into two types, viz., "inverted T" and "counterfort wall." The inverted T type has the advantage of being of much simpler shape and so requiring less form work than the other. Under ordinary conditions of foundation, cost of materials and labor, it is found to be economical up to a height of about 20 feet. The counterfort wall type was chosen on account of the closeness to the C.P.R. tracks, where traffic must not be interrupted. This fact made it necessary to have as much of the base as possible back of the face of the wall. Fig. 2 shows an elevation and sections of the north wall as designed and constructed. The horizontal earth pressure against the face of the wall between the counterforts is transmitted to them by the thin wall slab. Each counterfort was designed to resist the entire over-turning moment and bending moment produced by the resultant horizontal pressure of the earth. The portion of the base back of the wall was designed as a slab, carrying the weight of the earth above it and supported by the counterforts, and the portion in front as a cantilever fixed at the face of the wall and reinforced to resist the reaction of the ground. The tendency to slide is overcome by the sides of the excavation, which were cut to neat size of the base and the concrete poured up against the natural ground without any form. Additional safeguard against sliding was provided by making a projection on the bottom of the base at the back two feet wide and one and one-half feet deep. In this case no two counterforts were the same height in the same wall, which necessitated a separate design for each one. To prevent making the form work too expensive the space between the walls was increased from seven or eight feet (as is usually the case) to ten feet, with a corresponding increase in thickness of walls. The counterforts are 1.5 feet thick throughout. The same slope was used on the back of each one, so that the forms could be used on a counterfort of the same height, or on a shorter one by simply cutting it off at the bottom on the second wall. The wall is one foot thick on top with a coping two inches

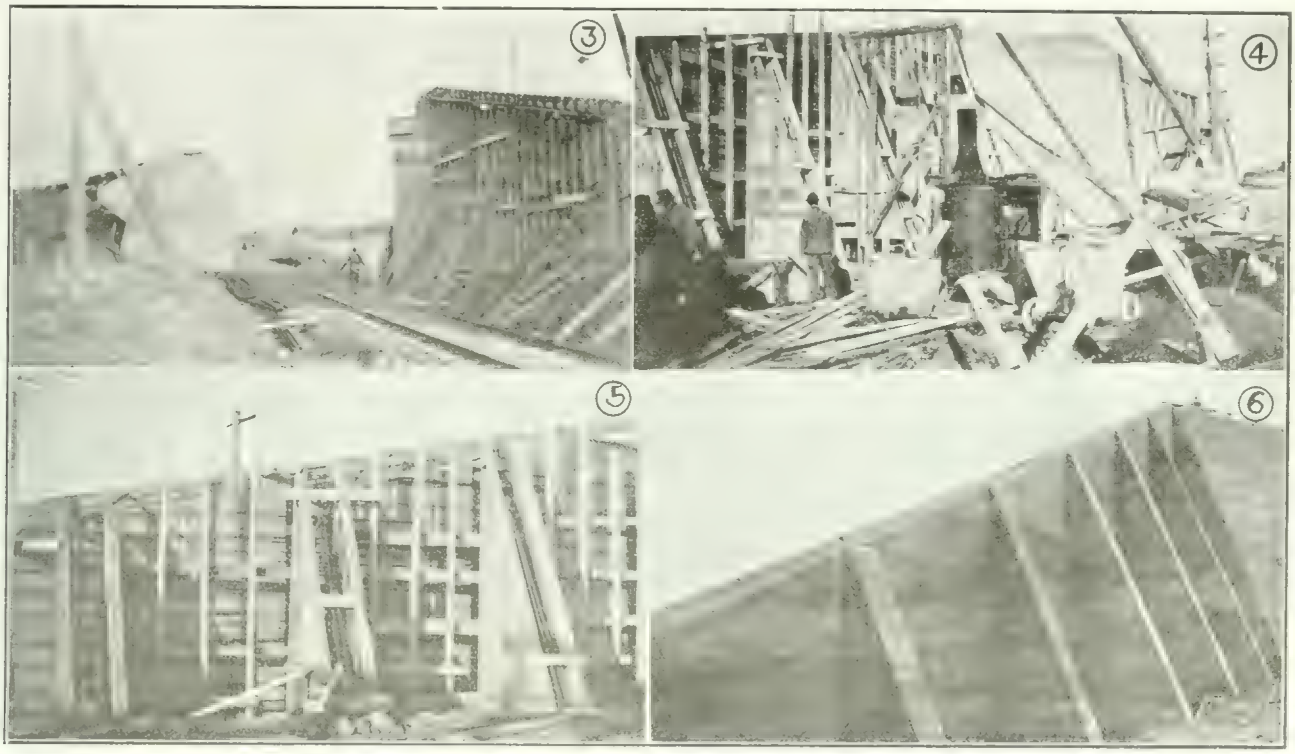

Fig. 3.—Abutments in place on either side of the C.P.R. line. Figs. 4 and 5.—Formwork and reinforcing of wall ready for concrete. Fig. 6.—Completed wall from counterfort side.

thick and one foot deep on the outside. The face of the wall has a batter of one-quarter of an inch to the foot and the back is plumb.

Three-quarter inch round rods of mild steel were used throughout with the exception of the backs of the counterforts where the tension strain to resist overturning was so great that it was considered best to use one and one-eighth inch round rods. The increased reinforcement required in the front of the wall, due to increased height, was taken care of by spacing the horizontal rods closer. The rods for the back of the counterforts were delivered from the rolling mills, cut the required length, while the three-quarter inch rods for the wall were delivered in thirty-two-foot lengths, which is the length of two spans with two feet for lap at the splice. This length is as long as could be conveniently loaded on cars. Care was taken that the joints in the adjacent rods did not come at one counterfort, this being accomplished to a large extent automatically by commencing each horizontal rod at the outer end of the wall. Splices in horizontal rods were made by giving a two-foot lap in all cases over a counterfort. Wherever possible, the end of all rods were hooked over a rod running at right angles to it.

After the excavation had been made for the foundation a layer of concrete about three inches thick was placed in the bottom to form a hard, uniform floor for the men to work on and to protect the clay from becoming worked up if the weather should be wet. It was not possible to erect any staging to do any work from the front of the wall on account of the closeness of the C.P.R., as is seen from Fig. 3. The form for the face was put in place and boarded to the top, the studding being allowed to extend to the three-inch base, which had been put in. The frames of the forms for the back and counterforts were put in place with just enough boarding to brace them strongly, these studs also being allowed to extend to the base. The ends of the studs may be bored out and the holes filled with concrete. On this frame was suspended the reinforcing steel, which was securely held in its proper position by wires and blocking. Figs. 4 and 5 show the reinforcing in place before concrete was put in. The concrete was mixed quite wet and dumped from a large bucket into chutes placed at short intervals along the wall. The boarding-up of the back of the wall and of the counterforts was kept only a short distance above the concrete so that an opportunity would be given the men to tamp the concrete. The carpenters and the tampers used the same staging and very little difficulty was experienced in getting the material well tamped and to present a smooth surface. The gravel used for the concrete was taken from a bar in the St. John River, was clean and sharp and consisted of quartz and granite stones and sand so mixed that it was not considered necessary to screen it or to add any other material. The concrete was composed of six parts of this gravel to one of cement. The wing wall was separated from the abutment by a vertical joint. It was not considered necessary to provide any other expansion joint in this length of wall. Fig. 6 shows a view of the back of the finished wall.

In the north or smaller wall there is 172.8 cu. yd. of concrete, 14,300 lbs. of steel rods, while the gravity walls would have required 324 cu. yd. of concrete. In the long or south wall there is 235.8 cu. yd. of concrete and 23,300 lbs. of steel rods, while in the gravity wall there would have been 478 cu. yd. of concrete. The actual cost of two walls was $6,817, and was constructed by contract for 82.5 per cent. of the cost of a gravity wall. The price paid per yard for reinforced concrete was about one dollar more than it should have been to be consistent with the price per yard of plain concrete. If the prices had been consistent the reinforced wall would have been constructed for 78 per cent. of the gravity wall.

Design of Abutments.—The abutments are of peculiar shape but do not present any particular difficulty, the general appearance of which may be seen in Figs. 3 and 7. They are of monolithic design, except for a small lug or wing on the side opposite to the large wing wall. The abutment is allowed to be partially submerged on side of the structure so little or no advantage could be gained by reinforcement.

Fig. 7.—Showing Special Type of Abutment.

Fig. 8.—Erection of Steel Girders.

Fig. 8 shows the steel girders being placed in position by the derrick car of the Dominion Bridge Company.

The design and drawings were made by Mr. W. G. Bullock, bridge engineer for the railway company. The construction was in charge of Mr. B. M. Hill, division engineer, and Mr. F. W. C. Wetmore, resident engineer. The concrete work was done under contract by Mr. W. H. A. Hamilton, Mr. E. S. Haines, superintendent, and steel superstructure by the Dominion Bridge Company, to all of whom credit is due for the careful and energetic manner in which the work was carried out.

PROPOSED EDMONTON BRANCH, CAN. SOC. C.E.

An application to establish in Edmonton a branch of the Canadian Society of Civil Engineers has, according to report, been granted. On May 1st a meeting was held by the resident members of the Society to discuss the organization of the proposed branch.

DESIGN OF STEEL AND REINFORCED CONCRETE PILLARS.

In a paper read recently before The Concrete Institute of Great Britain, Mr. Oscar Faber, B.Sc., dealt with the above subject, making special reference to secondary and accidental stresses. He divided his paper into two sections, first taking up jointed construction such as structural steel and afterwards monolithic construction, such as reinforced concrete. He examined the case of a girder resting on the end of a steel stanchion and stated that in several drawing offices he knew as a fact that the construction in such a case would be treated as centrally loaded. He proceeded to argue that such was not the case because, when a load was applied to the beam it would deflect and the end originally horizontal would assume a certain slope and therefore one of two things would happen, namely, (*a*) the end of the girder would lift, in which case the whole load would be carried on one flange, so causing eccentric loading; or, (*b*) the column must be constrained to adapt itself to the slope of the girder, in which case a bending moment would be introduced into the stanchion by such constraint. In this way he showed that increases in strains of 140 and 480 per cent. respectively were obtainable.

Mr. Faber took secondly for consideration the case of a girder resting on an angle bracket. He argued that if an ordinary bracket were used the action would not be very far from the face of the leg of the angle since the horizontal leg of the angle would not be strong enough to resist the bending moment which would be produced in it. It followed, therefore, that although the horizontal leg of the angle served a useful purpose in connecting the girder to the stanchion it must not be thought capable of supporting it. In effect the construction became dangerous if the clearing between the face of the stanchion and the edge of the girder exceeded the thickness of the angle. The author of the paper supposed there were few engineers who would assert that this limiting clearance was never exceeded in practice and an engineer had to carefully consider whether it was desirable to employ this type of bracket except for quite small reactions.

He next considered a stiffened bracket. Confining attention to cases where the workmanship was good, he assumed that the stiffening angles had been machined or forged to fit the angle bracket perfectly, and that the bracket was initially horizontal. It followed that, when the girder deflected there was a tendency for it to rest on the outer edge of the bracket, and for very small loads there was no doubt that this actually happened. As the load increased the outer edge of the stiffeners yielded appreciably, and a greater area supported the load, the reaction gradually approaching the face of the column. The author's practice was to make the web of the stiffeners sufficient in area to carry the reaction under a uniform stress of 7½ tons per sq. in.

In calculating the resistence, he ignored a large area of steel in the flange of the stiffeners, and in the vertical leg of the angle bracket because: (*a*) The clearance between the face of the stanchion and the end of the girder might be sufficient to prevent bearing on this steel; (*b*) even if it was not, this material could not be stressed appreciably until thé stiffener webs are greatly overstressed.

In any case, the difference in cost between good and bad brackets was an extremely small percentage of the cost of the steelwork, and a smaller one of the cost of the building, and he declined to endanger the "ship" for what, in this case, might be fairly described as a "ha'porth of tar."

It has long been recognized in good practice that the machining of the ends of stanchions was of the first importance. Yet, there were at least two constructional works in London which, with a view to economy, omitted this item of workmanship, and were erecting considerable tonnages of stanchions with the ends left so that the upper tier had contact with the lower tier over the width of one plate only, the remainder of the section having varying clearances often amounting to ⅛ in. The stress was still gaily calculated as uniformly distributed, and it had been explained to the author that "steel is a ductile material which would yield and flow" and perform other convenient antics, "until the stress was uniformly distributed." The effect of loading such a stanchion was to cause the plates to slide past one another, and to partly shear through the rivets. Even where stanchions are machined, a careful engineer must satisfy himself that they were machined truly square. Architects should bear in mind also that apart from the danger involved in these practices, the yielding of stanchions and brackets before they obtain their bearing involved unknown and unintended stresses on the stonework, and to the author's knowledge many a beautiful and costly facade and interior decorative work had been badly cracked by bad steelwork details and workmanship.

From the consideration of case 1, it would appear to follow that it was desirable to make these joints somewhat flexible, and occasionally this was so. If buildings were braced with diagonal braces, he should say without question, that stiffness of connections should be avoided. Unfortunately, such bracing had obvious objections, and the whole stiffness of practical buildings against wind laid in the stiffness between beams and stanchions. There was, therefore, no alternative but to make the joints stiff and to make the necessary allowance for these secondary stresses in the design of stanchions. This might be onerous, both in requiring extra labor and an increase in material, but a conscientious engineer would grudge neither the one nor the other.

Mr. Faber then dealt with the design of cleats. A common method of calculating the safe reaction of a cleat was to take it as the sum of the resistances of the rivets, the effect being to neglect the very appreciable stresses due to bending.

Dealing with the bracing of pillars, Mr. Faber said that it was well known that pillars failed by buckling and that their stress was to be determined with reference to their length. This phenomenon was fairly well understood and there are sufficient experimental data available to make the design of pillars, with reference to what he might call primary buckling, a comparatively simple matter. The phenomenon to which he referred was that of secondary buckling, in which the pillars, instead of buckling as a whole, fails by the individual buckling of its component members. On this subject there appeared to be practically no experimental data and practically no formulæ or rules for the guidance of a designer. The importance of this problem might be gathered from the fact that bad design in the matter of bracing in pillars was certainly responsible for the two greatest failures in recent years—the Quebec bridge of 1907 and the gasholder in Hamburg.

Mr. Faber then proceeded to the second portion of his paper, treating of monolithic construction and the eccentricity of beam reactions on pillars therein. Whereas in steel construction the eccentricity was very definite and

easily calculated with most common types of brackets, with reinforced concrete the eccentricity could only be calculated from considerations of elastic flexure, and the problem was a much more difficult one. There was, however, no longer any excuse for claiming ambiguity since the problem had been analysed very completely in "Reinforced Concrete Design" and numerical examples fully worked out. The author took as an example the case of the outside column of the building, working it out in detail, showing very great increases in stress over the values as ordinarily calculated. If thoughts of eccentricity were banished, either from ignorance or under stress of competition, the actual maximum stress would have been 1,300 lb. per sq. in. It is interesting to note that the outside pillar in good design did not suffer much reduction in size-up through the last three tiers. This was in accordance with the best practice in steel-frame buildings.

In conclusion, Mr. Faber said that without suggesting for a moment that the engineering staffs of several constructional firms were not fully as efficient as many consulting engineers, he did feel that the system of competitive designs and lump sum prices penalized good designing by such firms, and secured the work to those responsible for the most risky design. The only correct system, in his opinion, was for the architect to entrust the design to an engineer who had his confidence and to invite tenders on the design which he prepared. The architect and building owner were then likely to obtain a sound construction and if they used their discretion in the choice of the engineer the work would not cost more than the minimum consistent with safety.

The best constructional firms would be protected by being protected from competition with weak design and bad workmanship. In considering tenders, he held that an engineer should give preference to those firms whose detailing and workmanship he knew he could rely upon. He urged this in the interest of the building owner, knowing as he did the importance of good details and good workmanship.

OIL FROM CARBONACEOUS DEPOSITS.

Interesting data is gradually coming to light in regard to the employment of low temperature for distilling the various products from coal and other carbonaceous substances, and from these it appears that the distillation has been carried out more with the object of obtaining products other than oil. Since, however, oil has come to be one of the most important power producers attention has been directed to distilling carbonaceous substances with the sole purpose of obtaining oil therefrom, and there can be little doubt that this is a line of investigation and working which will occupy the most prominent place in the future.

Damage to the extent of $500,000 was done by fire which broke out on April 18 on the premises of the Alberta Lumber Company at Vancouver, B.C.

It has been announced at Pittsburg that a company has been organized to manufacture ferro-manganese from American ores, capitalized at $12,000,000, and to be located at Dunbar, Pa. Heretofore ferro-manganese has been imported from England and Germany, with the exception of small quantities manufactured by the largest interests for their own use.

The laying of telephone cables across St. John Harbor, N.B., is being planned and the New Brunswick Telephone Company has engineers busy selecting landing places for the cables. It is reported that tenders have been submitted by several companies for the supplying of the cables, and plans and specifications submitted. It is expected the work will be completed by July 1st. According to the engineers, [illegible] cables will be needed for the work.

PROGRESS ON THE SIMPLON TUNNEL.

It is probable that by the end of the year the Second Simplon tunnel, 12 miles 588 yards in length, will be half completed. It is the longest tunnel in the world and is being constructed in the Alps by the engineers of the Swiss federal railways to cope with the remarkable growth of tourist and goods traffic on the Simplon route. It runs parallel to the existing tunnel, and is being made by an enlargement of the parallel working gallery made by the engineers of the former tunnel. The cost is estimated at $6,925,000.

Apart from the use of explosives for blasting, compressed air is the sole power in use within the workings. The rock drills are operated by air, and the excavated material is drawn away by locomotives driven by air under a pressure of between 180 and 190 atmospheres.

One of the features of this new tunnel, according to a Swiss correspondent of The Engineer, is the adoption for the dry portions of the tunnel of a masonry lining of artificial stone instead of the natural stone hitherto employed in Alpine tunnelling. This artificial stone is composed of cement, limestone, and sandstone, and is being made at the Brigue end of the tunnel. The correspondent suggests that this new departure, which was strongly opposed at first, was influenced by the success with which composition stone and ordinary bricks have been used in England. The work of lining is stated to have been simplified by this new practice.

The nature of the rock at the northern end of the tunnel is stated to necessitate an immediate lining of the excavated portion, and timbering is being freely used to resist the immense pressure. No blasting is permitted during the passage of a train through the original Simplon tunnel, as the distance between the tunnel and the heading is only 26 feet. The risk involved upon the first tunnel is stated to have been estimated at $600,000.

The first Simplon tunnel, it may be remembered, was constructed by the Swiss firm of Brandt, Brandau, and extraordinary precautions were taken for protecting the health and lives of the workmen. The precautions, however, were justified by the results, and a singularly difficult piece of engineering was carried through with a marked absence of illness. The necessity for a parallel gallery for ventilation and drainage purposes made the progress with the original Simplon tunnel less rapid than that now taking place.

The first Alpine tunnel, the Mont Cenis, is seven and a half miles long, and took over 13 years to construct. The St. Gothard, nine and three-quarter miles long, took nine and three-quarter years; the Arlberg, six and a quarter miles long, three years; the Simplon, twelve and a quarter miles long, six and a half years; and the Lötschberg, nine miles long, four years. At the present rate of progress Simplon II. should be completed in about four and a half years.

The following is a statement of the sewers and surface drains laid during 1913 at Vancouver, B.C.

	Feet.	Miles.
Ward 1	4,680	.88
Ward 2	4,123	.78
Ward 3	1,336	.25
Ward 4	15,310	2.00
Ward 5	11,585	2.10
Ward 6	38,022	7.37
Ward 7	4,720	.89
Ward 8	6,249	1.18
	86,043	16.46

ELECTRICITY IN IRON AND STEEL MAKING.

The investigations that the U.S. Bureau of Mines is making into the metallurgical industries, the appliance of electricity to various processes, and especially in the manufacture of iron and steel, is given attention in Bulletin 67, "Electric Furnaces for Making Iron and Steel," just issued. It gives a historical review of the development of electric furnaces for making iron and steel, and discusses the problems which remain to be solved in the use of electric furnaces for the smelting of iron ores and the production of pig iron at a profit on a commercial scale. In discussing the electric furnace for the making of iron, it is stated that the electric furnace was not developed as a competitor of the blast furnace, but for the purpose of finding a furnace and a process that would be able to produce iron in those localities where blast-furnace practice was not feasible, or where the increasing cost of suitable fuel was becoming prohibitive to the existing practice of smelting in blast furnaces.

Broadly speaking, it is declared, it may be stated that the feasibility of smelting iron ores in an electric furnace depends upon the relative cost of either charcoal or coke and of electric power. As regards the latter, it must be cheap.

In those electric-furnace iron plants that are operating at the present time only hydro-electric power is used. The cost of producing power for electric-furnace work must, of course, vary with local conditions and hence depends upon the initial cost per kilowatt of installation. In general, there are few localities where the electric smelting of iron ores would be feasible with the electrical energy costing more than $20 to $30 per kilowatt-hour.

The second part of the report presents a brief historical review of the development of the electric furnace in the manufacture of steel up to the present time. The types of electric furnaces in commercial operation for the manufacture of steel and, in general, types which have not yet attained wide use, are described in detail. A description is given of the practice of the European and American electric-furnace steel plants, and a comparison made in a general was of the different types of furnaces and the more established methods of steel manufacture with the electric furnace process.

It is stated that the cost of making steel in the electric furnace varies with local conditions. The cost of power does not enter so largely into the final cost as it does in some other electro-metallurgical processes, especially the refining of molten steel. Plants are operating successfully under a power cost of 1 cent per kilowatt-hour in localities where material can be obtained at the price common to other processes. Plants such as the one at Ugine, France, have been established in remote localities, where the cost of power is very low, 0.2 cent per kilowatt-hour, but the cost of material is high.

For many years all high-grade steels were manufactured by the crucible process, but since the advent of the electric furnace there has been a gradual adoption of that furnace for refining steel. For the complete refining of the highest grades of steel the use of the electric furnace is now thoroughly established in Europe. Any product that can be made by the crucible process can be made by the electric furnace, and in most cases with cheaper raw materials and at a lower cost. In the electric furnace complex alloy steels can be made with precision. The high temperatures attainable facilitate the reactions and alloys need not be used so largely for the purpose of removing gas. Very low carbon steels can be kept fluid at the high temperatures. Steels free from impurities and of great value for electrical apparatus can be made. With the electric furnace large castings can be made from one furnace, whereas in the crucible process steel from several crucibles must be used. For small castings, which require a very high-grade metal free from slags and oxides, electrically refined steel is especially adapted. The electric furnace gives a metal of low or high carbon content as desired, hot enough to pour into thin molds and still free from slags and gases.

There is now a tendency among consumers of rail and structural steel to require a higher grade steel at an increased price rather than steel of acid Bessemer or even of basic open-hearth grade at a lower price. With the high cost of power that now prevails throughout the steel centres of the United States the electric furnace can not compete profitably with either the acid Bessemer or the basic open-hearth process in manufacturing steel of like grade from pig iron. It is in combination with either of these processes that the electric furnace seems destined to be prominent in steel manufacture. The cost of superrefining in the electric furnace the molten steel from either of these processes, exclusive of the cost of the molten steel, varies from $1.50 to $2.25 per ton, depending on the cost of power and the impurities to be removed.

THE ROAD MOVEMENT IN BRITISH COLUMBIA.

In the past 10 years the government of British Columbia has spent over $20,000,000 in roads and trails. There are in existence 20,000 miles of completed or partly completed roads, and in the recent budget speech of Hon. Price Ellison, Minister of Finance for British Columbia, it was stated that from all parts of the province have come numerous demands for roads, bridges, etc.

With a view to determining the requirements in the way of new roads, and in the bringing up to standard of existing roads, the Department of Works compiled estimates last year for the necessities of the immediate future. The information was derived from road superintendents throughout the province, and was supplemented by statements of the character of the country to be served and the reasons for their construction.

To link up the system of roads, as shown by the estimates received, will require the sum of $55,000,000, not including the requirements of the years to come. In a rougher way it has been estimated that between $100,000,000 and $125,000,000 will be ultimately required. When it is considered that since the census-taking of 1901 the population of the province has been increased by 350,000, in other words trebled, we can understand in some measure the increased demands on the treasury so created, not only in roads and trails, but in requirements of every character. Outside of the population of the various urban centres, there are 250,000 persons employed in the timber, fishery, mining and farming industries, and these are scattered from end to end of the province. The population of British Columbia will increase in a similar, if not greater, ratio for some years to come, and it is submitted as a wise and necessary policy that provision should be made as soon as possible for the inevitable needs of the near future.

The Maffel Schwartzkopf company of Berlin announces that it has defeated American competitors by obtaining a contract to deliver 14 high efficiency centrifugal pumps of 2,200 horse-power for the permanent pumping stations at Miraflores and Ancon, on the Panama canal.

ROAD BUILDING ECONOMICS

SOME NOTES ON BUILDING COSTS — RELATIVE 20-YEAR ECONOMY OF VARIOUS TYPES OF ROADS AND PAVEMENTS.

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THE advent and universal use of high-speed automobiles and heavy motor trucks have made the road problem one of the chief considerations of every municipality, whether it be a sparsely populated rural district, a village, a country town or a great city, and the economics of the subject are of greater general importance to-day than ever before. Various communities may require different classes of road construction but one and all must consider the economic value of the class of road they adopt. Road building being one of the oldest of undertakings there is an immense amount of reliable data on costs of construction, maintenance and deterioration of roads available for analysis, so that the question may readily be reduced to a simple business proposition and the relative economics of various types of road construction accurately recorded. In the following discussion, the various costs apply to average results attainable throughout the eastern section of the United States and though the same figures may not be capable of exact duplication in all sections, the relative economy of the various classes of road construction are proportionally accurate for any section, excepting, of course, for a particularly favored section where purely local facilities of material supply may favor some specific class of road building.

Before taking up a discussion of the various classes of roads, however, a few words on the financing of such undertakings is necessary. With few exceptions, roads are built by the federal government, the state legislature or a municipal board, and it makes no difference to the economics of the question whether the capital employed in building the roads is derived from direct taxation, the sale of bonds or whether the income from other source is employed, the capital invested in the roads must pay or carry a certain rate of interest. This value of the money may govern the economy of road construction in a certain locality—in one locality, one class of road may be relatively cheaper while in another, an entirely different class of road construction would prove the less costly, depending upon the rate of interest that the money employed in road building has to pay. Therefore, in order to make this discussion as comprehensive as possible, the capital charges and the interest charges will be kept separate. The establishment of a sinking fund for retiring bonds issued for road building operations does not materially alter the aspects of the case, retiring bonds before the completion of the road or during the life of the road simply reduces the net amount of interest paid on the capital directly involved in the road building operations by the use of other money that is just as valuable and entitled to the same profit.

Considered from a modern point of view, the available classes of road construction may be taken as macadam, paved and asphalt, and these three classes will be individually considered in that order. To arrive at a true valuation to put on any road the points that must be considered are: 1st, the initial cost of the road; 2nd, the average yearly maintenance charge of the road; 3rd, the life of the road, or the number of years that can be counted upon during which no extensive rebuilding is necessary; and 4th, the periodic rebuilding or renewal charge. The relative importance of these four conditions governing the economic value of the various classes of road construction are tabulated in Table I., for highways of 18-foot roadbed, to which reference will be made when considering the individual types of construction. The measure of economic value of the roads will be arbitrarily based on the total cost of the roads per mile for a period of twenty years as in such period the average road would have been subjected to the complete cycle of expenses to which it is subject and also as that length of time is frequently the period chosen for the life of construction bonds issued for raising the necessary capital.

TABLE I.

Average Road Building Costs Per Mile of 18-ft. Roadbed, etc.

Class of road construction.	Initial cost. $	Maintenance charge. $	Average life. Years.	Renewal charge. $
High-grade macadam	12,000	1,000	10	6,000
Paved roads, no foundations—				
Vitrified brick laid on edge	21,000	50	25	nil
Vitrified brick laid flat	11,000	55	1	11,000
Stone block	22,500	75	40	nil
Hard wood block	30,000	600	15	30,000
Soft wood block	23,000	800	12	23,000
Asphalt paving, no foundations	22,000	1,250	10	22,000

TABLE II.

Average Thickness of Concrete Foundations—Various Classes of Road.

Average cost, $1,100 per mile per inch depth, 18-ft. roadbed.

Class of road.	Thickness of concrete foundation.
Stone block paved	about 9"
Vitrified brick paved	4" to 6"
Hard wood block paved	about 8"
Soft wood block paved	about 9"
Asphalt paved streets	about 9"

Macadam Roads.—The severity of modern demands on roads is such that in considering roads of macadam construction one type only need be considered. The water-consolidated macadam construction has been almost entirely superseded by the tar macadam or similar construction. Without going into a detailed description of the method of construction of a high grade macadam road of modern development, such discussion being beyond the scope of this necessarily brief article, the average initial cost of construction per mile of 18-foot roadbed is very close to $12,000. The use of such roads is of necessity limited nowadays to comparatively small towns and as connecting highways between various cities or towns, etc., and are the most common class of rural highway construction. Their average maintenance charge should not, if the road is properly constructed, exceed $1,000 per mile per year, and they should not require renewal or reconstruction for a period of 10 years, at the expiration of which period they should be thoroughly overhauled and renewed at an average cost of about $6,000 per mile.

To arrive at the 20-year cost of a road, the measure of its true or net economic value, the various capital charges must all carry a certain rate of interest for the

period during which such investment is actually tied up in the road—i.e., from the time the investment is made until the end of the 20-year period that is taken as the measure of the economic value of the road. In algebraic form this is done in the derivation of Formula I., which equation conveniently expresses the 20-year cost of a high-grade macadam road of 18-foot roadbed in dollars per mile. The interest that a municipality has to pay for money is seldom less than 2 per cent. per annum and a community of any standing would rarely have to pay more than 5 per cent. These limits have considerable effect upon the 20-year cost of the road, however, and in the case of the macadam construction (see Example 1) the difference in the economic value of the road for which the capital was raised by an issue of bonds carrying interest at 2 per cent. and an issue bearing interest at the rate of 5 per cent., for instance, would be a sum equivalent to nearly 120 per cent. of the original cost of construction, the two issues of bonds being taken at equally advantageous terms.

Derivation of Formula I, 20-year cost of Macadam Highway per mile.

Macadam Highway—18-ft. roadbed.

Note:—I = yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile	$12,000	
Interest on initial cost (20-yr.)		12,000 x 20 x I
Renewal charge per mile (end of 10 years)	6,000	
Interest on renewal charge (10-yr.)..		6,000 x 10 x I
Maintenance charges per mile (18 x $1,000)	18,000	
Interest on 18 increments of $1,000 each, equivalent to		1,000 x 179 x I

20-year cost per mile = 12,000 + 240,000 x I + 6,000 + 60,000 x I + 18,000 + 179,000 x I.

20-yr. C = 36,000 + 479,000 x I. ....Formula I.

Example 1.

Required:—20-year cost of high-grade macadam road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively.

At 2% = 36,000 + 9,580 = $45,580.
3% = 36,000 + 14,370 = 50,370.
4% = 36,000 + 19,160 = 55,160.
5% = 36,000 + 23,950 = 59,950.

Paved Roads.—The second class of highway, the paved roads, are particularly adapted to modern requirements of resistance to traffic wear and to-day find an economic field in rural service as well as in its former particular field in cities and localities of congested traffic. The modern vitrified brick highway is the class of road construction that forms the common link between roads for urban and rural service and which at the present time has a tendency to revolutionize established road building practices.

Roads may be classified according to the two general kinds of service, urban and rural. The paved roads for city service are of stone block (blocks of granite or of stone of similar characteristics), vitrified brick and of hard or soft wood block construction. For country service the vitrified brick paved road has proved not only suitable but truly economic. These paved roads, one and all, require suitable foundations for supporting the paving and the most adaptable construction, ordinarily also the cheapest and most durable, is the concrete foundation. Old macadam roadbeds or similar foundations may be used in particular instances, but in a general consideration of the economics of road building it may be assumed that the correct and usual foundation for paved streets is that of concrete of thickness suitable for the service to which the road is to be subject. (See Table II.) The cost of excavation, etc., may also be grouped with the cost of the foundation so that in straight-ahead road work a reliably accurate average cost of foundations, including excavation, etc., is known that varies directly with the thickness or depth of foundations. This cost of foundations is approximately the same whatever class of paving is to be employed and a reliable figure for this expense is $1,100 per mile of 18-foot roadbed for each inch in thickness of foundations. Based on such general values, the 20-year cost of the various types of paved roads, the measure of the economic value of the road, will be taken up independently.

Stone Block.—Formerly the stone block paved road, such as is commonly known as "Belgian block roads" in many localities, was universally used for city service where the traffic was heavy and such construction is still by far the most lasting of pavements, a properly constructed road of such class having an average life of some 40 years, during which time the average total yearly cost of maintenance per mile of 18-foot roadbed should not exceed $75 per mile. Without going into the details of construction, etc., the initial cost of such a road without foundations is about $22,500 per mile. The thickness of foundation should be about 8 in. or 9 in., preferably the latter. In fact, certain of the more eminent road building engineers claim that heavy trucking on stone-paved roads demands a minimum thickness of 9 in. for supporting concrete foundations. The derivation of Formula II. is dependent upon the foregoing and clearly indicates the various interest charges that such class of road construction must carry. Example 2, giving the average 20-year cost of stone-paved roads built with capital of varying value, shows that, on account of the heavy initial expense and low maintenance charges of this class of road, the same proportional difference does not exist in the 20-year cost with capital of different value as when the initial cost is not so great and the maintenance expenses are greater.

Derivation of Formula II, 20-year cost of Stone Paved Roads.

Stone Paved Highway—18-ft. roadbed

Note:—I = yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$22,500	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations . .		22,500 x 20 x I
Foundations . . .		1,100 x t x 20 x I
Maintenance charges per mile (19 x $75)	1,425	
Interest on 19 increments of $75 each, equivalent to		75 x 100 x I

20-year cost per mile = 22,500 + 450,000 x I + 1,100 x t + 22,000 x t x I + 1,425 + 14,250 x I.

20-yr. C = 23,925 + 1,100 x t + (464,250 + 22,000 x t) I.
Formula II.

Example 2.

Required:—20-year cost of stone block paved road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation, 9″ thick.

At 2% = 23,925 + 9,900 + (464,250 + 198,000) 0.02 = $47,080.00
3% = 23,925 + 9,900 + (464,250 + 198,000) 0.03 = 53,702.50
4% = 23,925 + 9,900 + (464,250 + 198,000) 0.04 = 60,825.00
5% = 23,925 + 9,900 + (464,250 + 198,000) 0.05 = 66,947.50

Vitrified Brick.—The constantly increasing use of vitrified brick for paving both urban and rural highways makes the consideration of this class of road construction of particular and important interest at this time. In fact, it is this class of road construction by which its enthusiastic advocates plan a certain upheaval of past road building methods. Unquestionably the construction is economical and possesses many excellent points for both city and country roads, so that its adoption in many instances is good economic practice, even if not so in all cases. In all cases, unless local conditions are extremely favorable to some other kind of road, the vitrified brick highway built of brick on edge and supported by a suitable concrete foundation is the construction possessing the greatest 20-year economic value—i.e., the construction with the lowest 20-year cost. Another method of brick construction is the use of the brick laid flat as paving. The former method requires nearly 50 per cent. more brick for a given area than does the latter and correspondingly the average normal life of the type requiring the greater number of brick is more than twice that of the latter method. The average life, during which only comparatively light yearly maintenance charges are necessary, of the two methods of laying the paving being from 20 to 25 for the one and about 10 years for the less durable construction. The initial cost of the two types of vitrified brick roads, disregarding the cost of foundations or excavation, which is about the same for either, is, for brick on edge, about \$21,000 per mile of 18-foot roadbed and, for brick laid flat, about \$11,000 per mile. The former construction, having a life of 20 years or more, requires no renewal expenses during a 20-year period, simply a quite nominal maintenance charge of about \$50 per mile per year; the latter, having a life of but 10 years, requires complete rebuilding at the expiration of that period at a cost of about \$11,000 per mile, and during the years in which simply a maintenance charge is necessary for keeping the road in good repair, this maintenance charge amounts to about \$55 per mile per year. For urban service, the thickness of the suitable concrete foundation is about 6 in., while for rural roads a 4-in. concrete foundation is generally all that is required. Formulæ III. and III.-a give the average 20-year cost of vitrified brick roads of

Derivation of Formula III and III-a, 20-year cost of Brick Highways.

Vitrified Brick Highway—18-ft. roadbed.
Note:—I =yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations, brick on edge..	\$21,000	
Flat	11,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations, brick on edge..		21,000 x 20 x I
Flat		11,000 x 20 x I
Foundations		1,100 x t x 20 x I
Maintenance charges per mile brick on edge (19 x \$50)	950	
Flat (18 x \$55)	990	
Interest on 19 increments of \$50 each, equivalent to		50 x 190 x I
18 increments of \$55 each, equivalent to		55 x 179 x I
Renewal charge (end of 10 years) brick laid flat	11,000	
Interest on renewal charge		11,000 x 10 x I

20-year cost per mile (brick on edge) = 21,000 + 1,100 x t + 420,000 x I + 22,000 x t x I + 950 + 9,500 x I

20-yr. C = 21,950 + 1,100 x t + (429,500 + 22,000 x t) I.
Formula III

20-year cost per mile (brick laid flat) = 11,000 + 1,100 x t + 220,000 x I + 22,000 x t x I + 990 + 9,845 x I + 11,000 + 110,000 x I.

20-yr. C = 22,990 + 1,100 x t + (559,845 + 22,000 x t) I.
Formula III-a.

Example 3.

Required:—20-year cost of vitrified brick roads (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum—concrete foundations, 4" and 6" thick.

Brick laid on edge (urban service, foundations 6" thick).

At 2% = 21,950 + 6,600 + (429,500 + 132,000) 0.02 = \$39,780.00
3% = 21,950 + 6,600 + (429,500 + 132,000) 0.03 = 45,395.00
4% = 21,950 + 6,600 + (429,500 + 132,000) 0.04 = 51,010.00
5% = 21,950 + 6,600 + (429,500 + 132,000) 0.05 = 56,625.00

Brick laid on edge (rural service, foundations 4" thick).

At 2% = 21,950 + 4,400 + (429,500 + 88,000) 0.02 = \$36,700.00
3% = 21,950 + 4,400 + (429,500 + 88,000) 0.03 = 41,875.00
4% = 21,950 + 4,400 + (429,500 + 88,000) 0.04 = 47,050.00
5% = 21,950 + 4,400 + (429,500 + 88,000) 0.05 = 52,225.00

Brick laid flat (urban service, foundations 6" thick).

At 2% = 22,990 + 6,600 + (559,845 + 132,000) 0.02 = \$43,426.90
3% = 22,990 + 6,600 + (559,845 + 132,000) 0.03 = 50,345.35
4% = 22,990 + 6,600 + (559,845 + 132,000) 0.04 = 57,263.80
5% = 22,990 + 6,600 + (559,845 + 132,000) 0.05 = 64,182.25

Brick laid flat (rural service, foundations 4" thick).

At 2% = 22,990 + 4,400 + (559,845 + 88,000) 0.02 = \$40,346.90
3% = 22,990 + 4,400 + (559,845 + 88,000) 0.03 = 46,825.35
4% = 22,990 + 4,400 + (559,845 + 88,000) 0.04 = 53,503.80
5% = 22,990 + 4,400 + (559,845 + 88,000) 0.05 = 59,982.25

18-ft. roadbed, the former for roads where the paving is laid on edge and the latter where the brick is laid flat, the derivation of which explains the various charges that such roads must carry. Example 3 gives the average 20-year cost of these roads for both city and country service and a comparison of these costs with similar costs for any other class of road construction indicates that for a 20-year period such roads are apparently the most economical that can be constructed and explains the keen interest that has recently been taken in this class of road by administrative bodies.

Wood Block.—Noiselessness is the main advantage of any wood block paving and, though their slipperiness in wet and wintry weather is a drawback, they find a true economic and satisfactory use in city service. Both hard and soft wood blocks are used, the former usually simply being dipped in a mixture of tar and pitch or creosote oil before being laid, while the impregnating mixture is forced into the latter type of wood block under suitable pressure. Both kinds of blocks are laid upon foundations of concrete, floated in cement and grouted in either cement or pitch. Expansion and contraction, which ordinarily is greater and harder to control with the hard wood block, is taken care of by providing an expansion space along either curb, which space is usually filled with puddled clay. As in the case of all city streets, the width of roadbed is usually more than 18 feet, but, as the cost of any class of road depends directly upon the width of its roadbed, the 20-year cost of such roads will also be considered as 18 feet, so that ready companison of its true economic value can easily be made with the other classes of construction that have been and will be considered. The hard wood block paving is the more costly but it also has a somewhat longer life than the soft wood block paving and the latter carries a heavier maintenance charge per year. The various charges incidental to the two classes of wood block paving are itemized in the derivation of the Formulæ IV. and V., the former of

which gives the average 20-year cost of hard wood block roads per mile and the latter the average 20-year cost of similar roads constructed of soft wood block paving. Examples 4 and 5 give the average 20-year costs of hard and soft wood block roads respectively per mile built on concrete foundations of standard depth or thickness for city service with capital commanding from 2 to 5 per cent. per year. These examples would tend to indicate that the soft wood block road is in reality of higher economic value, lower 20-year cost, than the somewhat more durable hard wood block road, even though the foundations for the former are advisably somewhat thicker. Practice also confirms this deduction if the soft wood blocks are suitably and thoroughly impregnated with a mixture of tar and pitch or similar compound.

Derivation of Formula IV, 20-year cost of Hard Wood Block Highway.

Hard Wood Block Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$30,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations		30,000 x 20 x I
Concrete foundations		1,100 x t x 20 x I
Maintenance charges per mile 18 x $600	10,800	
Interest on 18 increments of $600 each, equivalent to		600 x 184 x I
Renewal charge per mile at end of 15 years	30,000	
Interest on renewal charge (5-yr.)..		30,000 x 5 x I

20-year cost per mile = 3,000 + 600,000 x I + 1,100 x t + 22,000 x t x I + 10,800 + 110,800 x I + 30,000 + 150,000 x I.

20-yr. C = 70,800 + 1,100 x t + (860,400 + 22,000 x t)I.
Formula IV.

Example 4.

Required:—20-year cost of hard wood block road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation 8″ thick.

At 2% = 70,800 + 8,800 + (860,400 + 176,000) 0.02 = $100,328.00
3% = 70,800 + 8,800 + (860,400 + 176,000) 0.03 = 110,692.00
4% = 70,800 + 8,800 + (860,400 + 176,000) 0.04 = 121,056.00
5% = 70,800 + 8,800 + (860,400 + 176,000) 0.05 = 131,420.00

Derivation of Formula V, 20-year cost of Soft Wood Block Highway.

Soft Wood Block Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$23,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations		23,000 x 20 x I
Concrete foundations		1,100 x t x 20 x I
Maintenance charges per mile 18 x $800	14,400	
Interest on 18 increments of $800 each, equivalent to		800 x 181 x I
Renewal charge per mile at end of 12 years	23,000	
Interest on renewal charge (8-yr.)..		23,000 x 8 x I

20-year cost per mile = 23,000 + 460,000 x I + 1,100 x t + 22,000 x t x I + 14,400 + 144,800 x I + 23,000 + 184,000 x I.

20-yr. C = 60,400 + 1,100 x t + (788,800 + 22,000 x t)I.
Formula V.

Example 5.

Required: 20-year cost of soft wood block road (18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation, 9″ thick.

At 2% = 60,400 + 9,900 + (788,800 + 198,000) 0.02 = $ 90,036.00
3% = 60,400 + 9,900 + (788,800 + 198,000) 0.03 = 99,904.00
4% = 60,400 + 9,900 + (788,800 + 198,000) 0.04 = 109,772.00
5% = 60,400 + 9,900 + (788,800 + 198,000) 0.05 = 119,640.00

Asphalt Paved Streets.—The popularity of asphalt pavement for city service lies not only in the freedom from noise but also in the ease with which such roads can be kept clean. The softening of the paving surface, if subjected to even the summer temperature of many localities, limits the use of this class of road to cities in the temperate zone, in even which localities the softening of the asphalt surface has much to do with the very high maintenance charge that is necessary to keep such roads in good repair. A maintenance charge of $1,250 per mile of 18-foot roadbed and proportionally greater for wider roads is about the charge that has to be carried even when the asphalt is laid on a good and firm concrete foundation. Without such foundation, the maintenance charge is even greater, but the more stable construction will only be considered. Asphalt paving laid over good stone paving supported on suitable concrete foundations also makes an excellent road, but such road is only built when local requirements demand the "noiseless" road where formerly a high-grade stone-paved but noisy road had proved satisfactory, so cannot rightfully be a road with an individual economic value. The 20-year cost of such road can, however, be easily ascertained by the use of the formula applying to the construction of a stone-paved highway in conjunction with the following equations pertaining to asphalt-paved streets. The economic value of such combination road would be high, as its life would be little, if any, longer than that of an asphalt street built on suitable concrete foundation without the intervening layer of stone paving.

Derivation of Formula VI, 20-year cost of Asphalt Paved Streets.

Asphalt Paved Highway—18-ft. roadbed.

Note:—I=yearly rate of interest.

	Capital charges.	Interest charges.
Initial cost per mile—		
No foundations	$22,000	
Concrete foundations	1,100 x t	
Interest on initial costs (20-yr.)—		
No foundations		22,000 x 20 x I
Concrete foundations		1,100 x t x 20 x I
Maintenance charges per mile 18 x $1,250	22,500	
Interest on 18 increments of $1,250 each, equivalent to		1,250 x 170 x I
Renewal charge per mile at end of 10 years	22,000	
Interest on renewal charge (10-yr.)..		22,000 x 10 x I

20-year cost per mile = 22,000 + 440,000 x I + 1,100 x t + 22,000 x t x I = 22,500 + 123,750 x I + 22,000 + 220,000 x I.

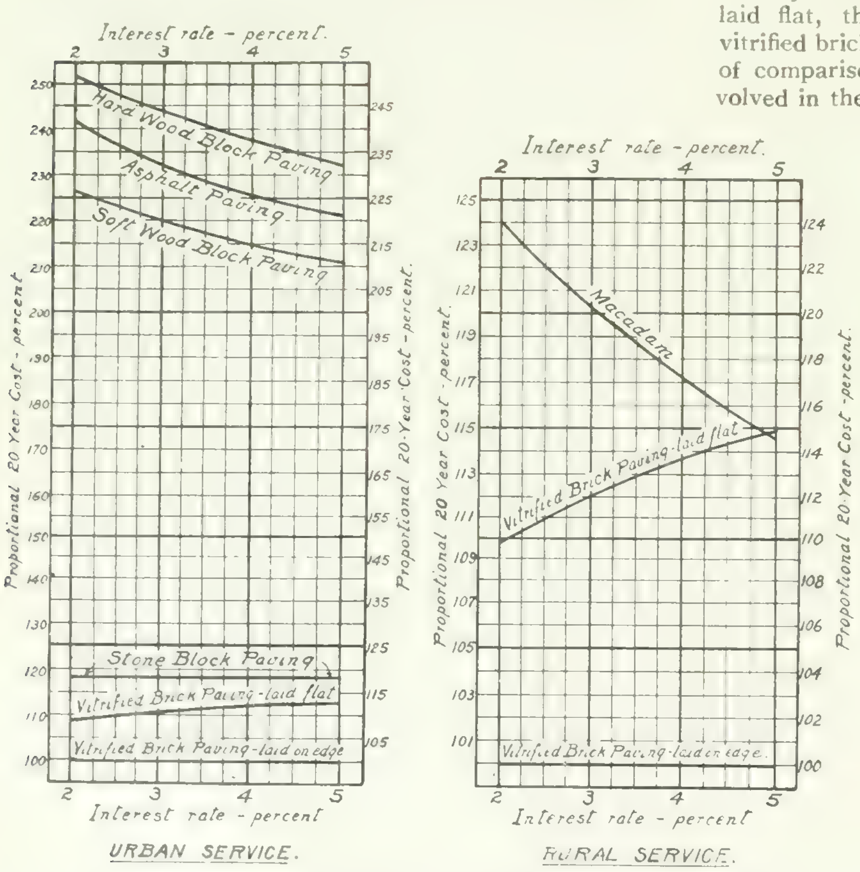
20-yr. C = 66,500 + 1,100 x t + (783,750 + 22,000 x t)I.
Formula VI.

Example 6.

Required:—20-year cost of asphalt paved street 18-ft. roadbed) per mile, money at 2, 3, 4 and 5 per cent. per annum respectively—concrete foundation, 9″ thick.

At 2% = 66,500 + 9,900 + (783,750 + 198,000) 0.02 = $ 96,035.00
3% = 66,500 + 9,900 + (783,750 + 198,000) 0.03 = 105,852.50
4% = 66,500 + 9,900 + (783,750 + 198,000) 0.04 = 115,670.00
5% = 66,500 + 9,900 + (783,750 + 198,000) 0.05 = 125,487.50

The life of a well-laid and well-constructed asphalt street is rarely much more than ten years, at the end of which period the street requires complete renewal at a cost of about $22,000 per mile of 18-foot roadbed. Notwithstanding these heavy expenses, the asphalt paving continues to be extensively used and does make an excellent city highway where traffic is not too severe. In fact, its 20-year cost (average) shows that its economic value in urban service is greater than that of the hard wood block street and about equally more expensive than the soft wood block construction, the 20-year cost of an asphalt road being about a mean between similar costs of hard and soft wood block paved streets. The usual foundation construction for paved streets is ordinarily resorted to for the asphalt street as well, so the average cost of foundations is applicable to such construction. The various charges that the ordinary high-grade asphalt highway is called upon to carry are all itemized in the derivation of Formula VI., by which equation the average 20-year cost of an 18-foot highway of asphalt paving per mile can be readily ascertained. Example 6 gives the average cash outlay necessary for such roads built on concrete foundations 9 inches thick, the depth of foundation required for satisfactory city service, with capital of values of from 2 to 5 per cent. per annum.



Figs. 1 and 2.—Relative 20-year economy of various classes of roads built with capital bearing interest at from 2 to 5 per cent. per annum.

A comparison of the various examples that have been given shows that the cheapest road, as far as 20-year cost is concerned, is, both for rural and urban service, the vitrified brick highway built of brick on edge. Comparing the 20-year cost of other classes of roads with that of roads paved with vitrified brick laid so as to develop the greater life and representing such basic cost as 100 per cent., the relative 20-year economy, as measured by the proportional 20-year cost, of various classes of roads is graphically depicted on Figs. 1 and 2, the roads being classed as to their use for urban or rural service. A study of these charts emphasizes certain interesting points, among which not the least interesting is that the past road building practice has not been as incorrect as modern revolutionists in the science of building roads have implied. It is true that what may be termed a relatively modern vitrified brick road is the most economical in 20-year cost for both city and country service, but that in order to realize the full economy of the brick road the brick must be laid on edge. The cheaper construction (cheaper in initial cost) of laying the brick flat, though relatively economical when money for road building is cheap, decreases in economy as the money used from construction increases in value. For urban service, the vitrified brick road with brick laid flat is little more economical in 20-year cost than the stone block road when the value of the capital so invested approaches 5 per cent. per annum. For rural service, the type of lesser economical brick construction is less economical than high-grade macadam when money is worth 5 per cent. With the solitary exception of the vitrified brick road with brick laid flat, the proportional 20-year cost—the economic vitrified brick construction serving in all cases as the basis of comparison—of all roads diminish as the capital involved in their construction becomes more valuable. This does not mean that it is cheaper to build with expensive capital but that, should a road of relatively high 20-year cost be constructed with money commanding a high rate of interest, the proportional increase in cost compared to that of a vitrified brick highway (20-year cost) would not be as great as when capital can be obtained at more advantageous terms. The chart showing the relative 20-year economy of rural roads is of particular interest in that it brings out the fact that the small community which has to pay a high rate of interest for its money is in a much better position to afford a high-grade macadam road—in fact, such road is usually the only possible one for such a community, owing to its comparatively low initial cost—than a more important community more fortunately situated, as far as obtaining money at a low rate of interest is concerned.

The great discrepancy in the proportional 20-year cost of wood paved or asphalt streets and of the stone or vitrified brick paved streets for city service cannot be taken as truly indicative of the respective economic value of the "noisy" and the "noiseless" streets, for between these two varieties comparison can only be made when a true valuation can be put on noise, or, rather, lack of noise. Local requirements must decide such point and the convenience of the public be the gauge of economic value of the respective varieties. However, the urban service chart shows that the six available classes of road naturally divide themselves according to their freedom from noise and a comparatively wide choice of construction exists for either the "noisy" or the "noiseless" street.

LAST SPIKE IS DRIVEN

At the Nechako River Crossing, British Columbia, the last link in the construction of the Grand Trunk Pacific Railway was undertaken recently. Construction on this road was started in 1905 and 2,000 miles of track have now been laid, the last spike being driven 371 miles east of Prince Rupert and 1,375 miles from Winnipeg.

The main line of the Grand Trunk Pacific extends from Winnipeg to Prince Rupert, B.C., a distance of 1,746 miles. The line first follows the Assiniboine Valley in Manitoba and runs through a district well settled before the advent of the railway. From Portage la Prairie west the district traversed was practically a new one, and one in which colonization and development have been due to the railway. Saskatoon and Edmonton are the only cities which existed and which had railway facilities prior to the advent of this railway. Now the country is dotted with towns in all stages of development.

The following is a list of branch lines covered by Grand Trunk Pacific Branch Lines Company:—

	Length, Miles.	Total Miles.
Manitoba—		
Harte-Brandon branch	25	25
Saskatchewan—		
Melville-Canora	55.2	
Melville-Regina	98.4	
Regina-Boundary	155	
Regina-Moose Jaw and North West	108	
Prince Albert Branch	111.8	
Battleford Branch	48.5	
Cut Knife Branch	50	
Biggar-Calgary	104.06	
		730.06
Alberta—		
Tofield-Calgary Branch	201.5	
Alberta Coal Branch	56.4	
Mountain Park Coal Branch (operated)	30.24	
		288.14
		1044.10

Of the above the following is now in operation. The entire mileage will be in operation during 1914:—

	Miles.
Melville-Canora	55.2
Melville-Regina	98.4
Regina-Boundary	155
Regina-Moose Jaw and North-west	90.2
Prince Albert	67
Battleford	48.5
Cut Knife	33.6
Biggar-Calgary	104.06
Tofield-Calgary	201.5
Alberta Coal Branch	56.4
Mountain Park Coal	30.24
	940.10

Under the Grand Trunk Pacific Saskatchewan Railway Company's charters construction has been begun on the branch from Talmage to Weyburn, and the line is completed except for track work, and will be in operation during 1914. Weyburn Branch, 15 miles in length.

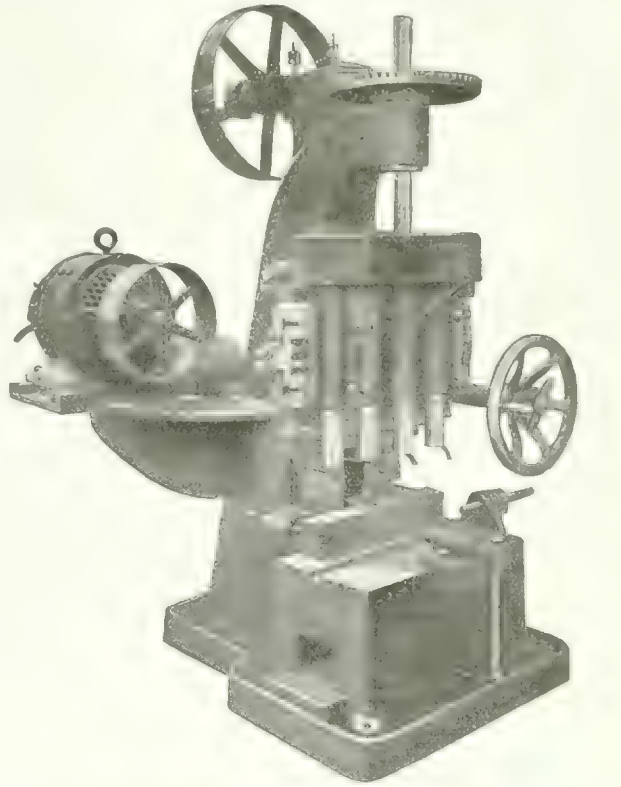
	Miles.
Total mileage of branch lines completed and in operation	940.10
Begun and to be completed	119.00
Total to be in operation in 1914	1059.10

The annual meeting of the shareholders of the Steel Company of Canada was held on April 27 at Hamilton, when the following officers were re-elected:—C. S. Wilcox, president; C. A. Birge, vice-president; Robert Hobson, vice-president and general manager; directors, Charles Alexander, Providence, R.I., W. D. Mathews, Toronto; John Milne, William Southam, Hamilton; Sir Edmund Osler, Toronto; F. H. Whitton, Hon. William Gibson and Lloyd Harris, Brantford; S. H. Champ, secretary-treasurer. The directors' report, which stated that last year was the best in the history of the company, was adopted. It was stated that the plant was just now running irregularly, as work came in. The opinion was expressed that the change in the tariff would benefit the company.

A NEW RAIL DRILLING MACHINE.

The rail drilling machine shown in the illustration possesses some new and interesting features.

The three holes for the fish-plate bolts and the hole for the rail bond are all drilled at the same time. The three right-hand spindles are for the bolt holes, and these are arranged so that the distance between centres of the holes can



be adjusted from 3½ to 9 inches. The left-hand spindle is for the rail-bond hole; it keeps a constant distance of 6 inches from the last bolt hole.

All the spindles are mounted on a saddle and can be moved vertically in unison. The saddle is counter-weighted and has two changes of power feed in addition to hand adjustment.

The machine is made by the Newton Machine Tool Works, Philadelphia. A 10-h.p. Westinghouse electric direct current motor furnishes the power.

The following is a statement of work in connection with the waterworks distribution system at Vancouver, B.C., for the year 1913. Details of mains laid are as follows:—

Size.	Pipe Laid, Lin. Ft.
2-inch	10,655
4-inch	794
6-inch	78,962
8-inch	36,449
12-inch	31,128
24-inch	21,300
32-inch	21,300
	200,588

Details of valves placed in 1913 are as follows:—

2-inch	[illegible]
4-inch	31
6-inch	287
8-inch	100
12-inch	[illegible]
18-inch	1
24-inch	4
32-inch	2
	[illegible]

No. of hydrants placed this year, 1913	229
No. of hydrants in use in city	1,657

COAL AND COKE PRODUCTION IN BRITISH COLUMBIA, 1912-13.

The preliminary review and estimate of mineral production, 1913, published by the British Columbia Bureau of Mines in Bulletin No. I., 1914, states that preliminary returns received show a gross production in 1913 of about 2,577,000 long tons of coal, as compared with nearly 3,026,000 tons in 1912. The quantity made into coke was 440,000 tons, leaving 2,137,000 tons as the net production of coal. The quantity of coke made was rather more than 285,000 long tons, which constitutes a record in production of coke in the province, the highest previous year's output having been that of 1905, of 271,785 tons. For purposes of comparison the following table is shown:—

		1913.	1912.	1911.	1910.	1909.
Coal, gross	tons, 2,240 lbs.	2,576,886	3,025,709	2,297,718	3,139,235	2,400,600
Less made into coke	"	440,192	396,905	104,656	339,189	394,124
Coal, net	"	2,136,694	2,628,804	2,193,062	2,800,046	2,006,476
Coke made	"	285,123	264,333	66,005	218,029	258,703

When the year opened the Canadian Collieries (Dunsmuir), Limited, had succeeded in considerably increasing the output from the mines of its Comox Colliery, notwithstanding that the United Mine Workers of America had for several months required its members to abstain from working in those mines owing to the persistence of the company in its determination not to recognize that organization. Having got its production almost up to normal quantity at its Comox mines, the company next gave its attention to its Extension mines, at which a strike had also been declared by the union. Other measures having failed to prevent progress being made at Extension Colliery as well as at Cumberland (Comox Colliery), the United Mine Workers of America declared a strike at all coal mines on Vancouver Island, with the result that the miners of the Western Fuel Company, Nanaimo, had to violate their unexpired agreement with that company and cease work. The strike also affected the mines of the Pacific Coast Coal Mines, Limited, operating at South Wellington, Morden, and Suquash, and of the Vancouver-Nanaimo Coal Mining Company working the Jingle Pot mine near Nanaimo. With the exception of the last-mentioned company, the operators continue to decline to accede to the demands of the United Mine Workers of America, and the position at the close of the year was that the Canadian Collieries Company was working its Cumberland mines to full ordinary production capacity, and its Extension mines to about the extent it was doing when the general strike was called at the end of April; the Western Fuel and the Pacific Coast Coal Mines Companies were working with comparatively small forces of non-union men, yet were producing some coal; and the Vancouver-Nanaimo Company had all the union men it could find work for.

While the labor troubles at Vancouver Island mines had caused a decrease in production of coal to the estimated extent of approximately 596,000 tons, there were increases in Nicola and Crows Nest Districts of about 57,000 and 90,000 tons, respectively, which reduced the decrease in the coal production of the province as a whole to a net total of about 449,000 tons. The gross production of the several districts was as follows:—

	Tons of 2,240 lb.
From Vancouver Island mines	962,620
From Nicola and Similkameen mines	262,768
From Crows Nest mines	1,351,498
Total quantity of coal produced	2,576,886
Less made into coke	440,192
Net quantity of coal produced	2,136,694

Leaving out of account the present interruption to production at some of the Vancouver Island coal mines, the statement appears to be warranted that on the whole the coal mining industry of the province is in a progressive condition. That this is so is demonstrated particularly by the considerable developments of mines and large additions to plant and machinery made by three of the four companies operating on Vancouver Island. Some particulars of important development work and new equipment now referred to were given in the Annual Report of Minister of Mines for 1912.

In the Nicola field, the Inland Coal and Coke Company made the largest output of coal of any in the district—about 116,000 tons, compared with 31,000 tons in 1912. No considerable addition to plant was made. The chief new development work done was driving a new slope—No. 5. High railway freight rates prevented the Nicola Valley Coal and Coke Company from extending its market, so its output of coal was comparatively small—about 110,000 tons, as against nearly 143,000 tons in 1912. In addition to continuing operation of mines previously worked, the company opened Nos. 7 and 8 mines. In No. 7, situated near the top of Coal Gully hill, the main slope has been sunk 500 feet and is being extended; from this a number of working places have been opened off, giving the mine a present output capacity of nearly 200 tons of coal a day from a 16-foot seam of excellent coal. In No. 8 there is a 6-foot 6-inch seam which is promising, but sufficient development has not yet been done to determine its value as a producer. The company could mine and ship 750 tons a day if called upon, but there is not a present demand for so much. Even the Canadian Pacific Railway Company's requirements of coal are smaller now than in the past, as many oil-burning locomotives have been substituted for coal-burners. The Diamond Vale Collieries Company increased its small output from 3,300 tons in 1912 to 6,300 tons in 1913, and the Pacific Coast Colliery Company made a beginning with a production of 462 tons of coal.

There was little change in the Similkameen field. The output of 28,800 tons made by the Princeton Coal and Land Company was only a few hundred tons larger than in 1912. The United Empire Company made little progress, its output having been quite unimportant. The Columbia Coal and Coke Company's property changed ownership, and its new owners commenced to develop a different part of the property to that in which the first management of the Columbia Company had done much work without profitable result.

Both the Crow's Nest Pass Coal Company and the Hosmer Mines, Limited, made a larger production of coal in 1913 than in 1912. The output of the first-mentioned company was approximately 1,041,000 long tons of coal, gross, or, after deduction of 333,000 tons made into coke, 708,000 tons net. Its coke output was 225,480 long tons, as against nearly 219,000 tons in 1912. During the year the company developed what is known as "B" seam, which lies 320 feet above No. 1 seam of the Cool Creek measures, and thus provided for a present addition of about 500 tons a day to the producing capacity of its Coal Creek Colliery. At its Michel Colliery, the company developed two new mines above the old workings of No. 8 on the north side of the valley, and in this connection a skip incline was constructed to convey the coal down the mountain to the tipple level, the incline grade starting at 30 per cent. and increasing to 60 per cent. toward the lower end. The skips or cages carry 8 tons of coal and are easily controlled by rotary multiple brakes over a distance of 1,280 feet in eighty seconds. A profitable production is expected from these new openings in the ensuing year. Much prospecting work was done on the south side of the valley, where a new seam was found about 150 feet above No. 3 seam. A working section of about 10 feet of coal of generally good quality was opened here. As indicating favorable working conditions throughout the last year, it may be mentioned that the output of the company's Coal Creek Colliery exceeded that of 1910 (1911 was not a full year as regards operation of mines) by about 230,000 tons, while the quantity of coke made at the ovens at Fernie was about 9,600 tons greater than that of the previous record year, and nearly 44,000 tons higher than the coke production of 1910. There is promise of considerable improvement at both Coal Creek and Michel Collieries in 1914, especially at the mines of the latter, and it is hoped that the economic development work now in progress at the Coal Creek mines will materially enhance the general results.

Only a brief summary of the year's operations at the colliery of the Hosmer Mines, Limited, has been obtained. The output of coal was about 237,500 long tons, gross. Approximately 107,000 tons were used in making coke, leaving a new output of coal of 130,500 tons. The amount of coke made was about 59,600 long tons. The increase for 1913 as compared with 1912 was, therefore, in gross production of coal, about 49,000 tons (or 14,000 tons net), and in coke 14,200 tons. There was not any new mining development during the year. Improvements and additions to the plant included double-tracking "B" incline, and adding another drum to the engine operating the same; installing an 8-foot diameter Sheldon-Keith wheel-fan for ventilating "No. 2 B" south mine; and providing a steam locomotive for the rock bank and boiler coal.

At the Corbin Colliery, a fire, due to spontaneous combustion, necessitated the closing of No. 1 mine in April, and it was kept closed throughout the remainder of the year. No. 4 mine was opened after No. 1 was closed; it is on a seam which is really a branch off the No. 1 seam, and has a present production of about 250 tons a day. No. 3 mine, known as the "Big Showing," was provided with transportation facilities, the railway to it from Corbin, eight miles in length, having been completed in the first half of the year. This mine is situated nearly 1,000 feet higher than No. 1, which is near the level of the valley. In No. 1 mine the coal seam is nearly vertical and varies greatly in size. W. W. Leach, of the Geological Survey of Canada, described it as varying from a minimum thickness of 10 feet to a maximum of nearly 250 feet. This great difference, he said, may be due to compressed monoclinal folding. At the upper mine the coal has been stripped of the overburden near the top of the hill, and it is shown in a synclinal basin about 370 feet in width, the thickness of the coal near the centre having been proved by drilling to be more than 100 feet. During the summer and autumn, coal in No. 3 mine was worked in open cuts by a steam shovel, and sent down the switchback standard-gauge railway for shipment. The snowfall being heavy, open-cut working is not practicable in winter, but about 150 tons of coal a day is being mined underground here. A Marcus screen has been purchased for this colliery, but it will not be put in until next spring.

Of the new coal fields in various parts of the province there is little to report so far as concerns the probable early production of coal. In the Upper Elk River District, so far as known, there was not any advancement made toward the utilization of the large quantity of coal occurring in that part of the province, which has been estimated by D. B. Dowling, of the Geological Survey of Canada, as covering an area of 140 square miles, and containing approximately 14,000,000,000 tons of coal that can be mined. Until railway transportation shall be provided, this important district will remain undeveloped. Neither in the northern part of Cariboo District nor in the North Thompson River country, in both of which coal is known to occur, is there present prospect of production. Prospecting work done on coal measures on Graham Island of the Queen Charlotte group, has not yet resulted in any production of coal worth mentioning. More development work has been done on coal properties in parts of the Skeena District tributary to the Grand Trunk Pacific Railway, the construction of which is now nearing completion, and some attention has also been given to properties in Groundhog basin, in the northern part of Skeena District, but the latter is without transportation facilities and not much progress has been made.

A LARGE CONCRETE BRIDGE.

A concrete bridge which is being built at Pasadena, Cal., is the longest and highest bridge in the South-West. The roadway, 28 ft. wide between kerbs, is 160 ft. above the channel of the Arroyo Seco, a stream flowing beneath the finest residential section of the city, and the length of the [illegible] apart from its long sweeping curve is the series of arches, the largest of which is 223 ft. from centre to centre of the piers, while there are two spans of 151 ft. and six of 113 ft. each. The arch spans consist of two continuous elastic arch ribs carrying spandrel columns and in part spandrel walls. These support cross beams with cantilevered ends. The massive piers rest upon the boulders and gravel of the stream bed and are tested to 11,000 lb. per sq. ft. Cement to the extent of more than 10,000 barrels was required for the concrete, which is reinforced with corrugated bars of the strength of from 60,000 lb. to 70,000 lb.

The [illegible] ly been equipped with machinery for testing materials of construction, comprising appliances for performing impact, tension, torsion and transverse strain tests.

A communication [illegible] ers at Edmonton by Bosley Brothers of Brooks, Alberta, proclaims confidence in the presence of natural gas near Edmonton. They stated that they had a proposition to put before the civic authorities whereby the city could own its wells and have an [illegible] It would only to have to be piped 5 miles to the centre of the city. They stated also that there was no limit to the supply; the pressure would be good; [illegible] would not exceed 1,300 feet.

A RETAINING WALL AT SMALL COST.

By C. D. Norton.

THE retaining wall illustrated here was designed for the village of Orono, Ont., on the Canadian Northern Ontario Railway, some 50 miles east of Toronto. It was necessary to widen the street running parallel to the long wing, and as the existing culvert was

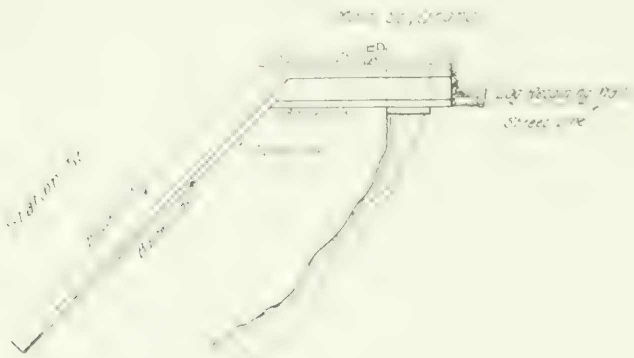


Fig. 1.—Location of Retaining Wall at Orono, Ont.

in very bad condition, it was decided to replace both it and the cedar retaining wall with a concrete structure. The old culvert was of rubble laid in lime mortar, which had become disintegrated by the weather. In addition, roots of plants and trees had penetrated the masonry, rendering it very unstable.

The limited sum of $500 was at the disposal of the village trustees, which necessitated careful study to secure a substantial structure at a minimum cost.

The loose masonry was pulled down until there was a good foundation for the concrete, and on the rest of the wall the excavation was carried down far enough to secure a good bottom, the average depth being 2 feet; the earth excavated was carefully packed after the forms were removed.

To be literally correct, the wall could hardly be termed "concrete," rubble laid in cement being more appropriate. Forms were used in the usual manner, a layer of concrete poured in, on which field-stone was carefully packed until the whole space was filled, care being taken that the stones did not touch each other. This procedure was carried out until the wall was complete.

After the forms were removed the wall was left to cure for six weeks, and then the backing was carefully tamped in.

The contractor was paid at the rate of $4 per cubic yard for the concrete, and the excavation was paid for at cost plus 10 per cent., the contractor finding everything. He used a motor-driven, ¼-yard cylindrical mixer, and had to haul his cement, lumber, and machinery five miles. Stone and gravel cost nothing, gravel being hauled half a mile. Labor cost at the rate of 17½ cents per hour. An exact record of the cost could not be obtained, as the work was very intermittently done, and the contractor had no system of cost-keeping.

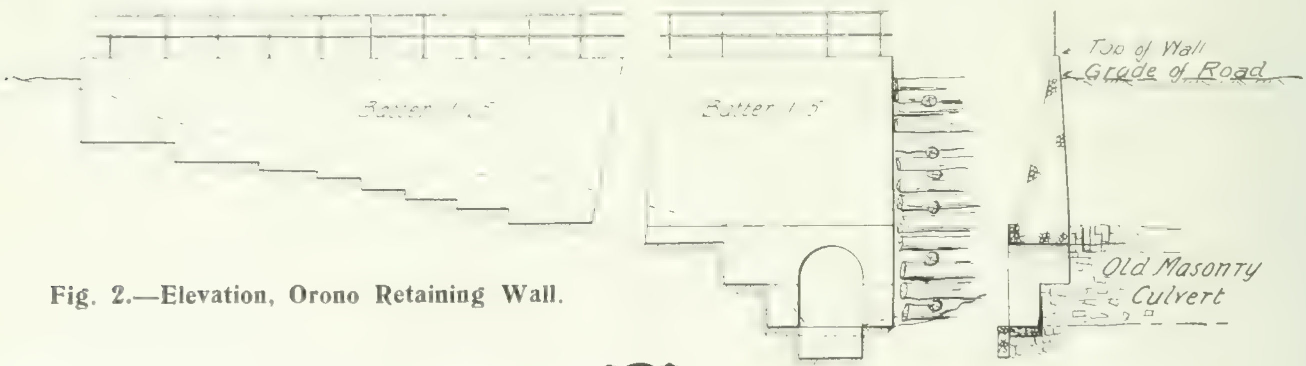


Fig. 2.—Elevation, Orono Retaining Wall.

HEAT JUDGING IN FOUNDRIES.

It is the custom in foundries to judge the heat of the molten metal by the eye, before pouring it into the moulds, and in comparatively few foundries is that use made of the pyrometer which its importance merits. The prevailing rough-and-ready method must result in a large proportion of defective work. No matter how accurate a man's eye may be, it will be evident that in every-day foundry work he has to use it under varying conditions and it is next to impossible that his eye can follow these as quickly as they change. It is not an easy matter to train the eye to judge the heat of molten metal from its color; but it may be said at once that it is impossible for the judgment to be accurate unless the light in which the metal is viewed is invariably the same.

The principal drawback to the use of pyrometers in furnaces in which the temperature is upwards of 1,000° C., is the destructive effect of the heat on the mechanism of the instrument. This difficulty, in fact, was not overcome until the introduction of the radiation or optical methods of temperature measuring. In radiation pyrometers it is possible to measure the heat radiated from the hot body, in various ways, by the effect it produces. Among these may be mentioned that of measuring the electricity produced when the radiation is made to heat a joint between dissimilar metals and that of measuring the alteration in the electrical resistance of a metal ribbon when exposed to radiated heat. In a particularly interesting form of pyrometer some of the heat rays from a hot body are concentrated by means of a concave mirror on to one junction of a small thermo-electric battery. When the junction is heated it sets up an electro-motive force, which is caused to pass through a galvanometer which is calibrated in degrees of temperature. The necessity of employing a galvanometer is a weak spot, as by it complications are introduced which it were well to be without. It is necessary, for example, that the instrument should stand on a perfectly level bed. It must not be exposed to outside magnetic influence, and it is of vital importance that the wires from the pyrometer to the galvanometer should be well insulated, as any leakage of current would affect the reading. A form of pyrometer was recently brought out, however, by the inventor of the one mentioned, which has all the advantages and none of the disadvantages of the older form. In it the galvanometer and the insulated wires are done away with, and it is consequently far more easily handled. The construction is quite simple and there is little or no possibility of errors occurring when the instrument is used. Instead of the heat rays, as in the earlier form, being concentrated on a small thermo-electric cell, they are focused on a small spiral strip formed of two ribbons of dissimilar metals. When heated this spiral gradually unwinds by reason of the different coefficients of expansion of the two metals, and, as can readily be seen, it is not a difficult matter to devise a means whereby the amount of this movement can be measured and expressed in degrees of heat.

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CONTENTS OF THIS ISSUE.

APPLICATION OF SCIENCE TO INDUSTRY.

The art of producing from one form of substance other forms for which there is a demand is known as Industry. When this production is accomplished by a process which incurs the least cost and turns out the best article commensurate with that cost, the art is experiencing maximum efficiency. Few industries have reached the sphere of this stage of perfect operation.

To Science has been applied the term "exact knowledge"—an exceedingly broad definition but a very significant one when the scientist is considered in relation to industrial operations. Reflection upon the accomplishments of the past century attributes its many epoch-making inventions to this exact knowledge. Science, in the brief space of 100 years, has produced facilities that have transformed civilization, by a series of innovations that arose out of the subtle method of theory and experiment.

What might be achieved if Science and Industry were made to work more in sympathy with each other is to be learned from the results of the application of the former to almost every industrial process in Germany. The "Made in Germany" tag has attained prominence in commercialism the world over. In the coal industry there is an example of the effect of Science, that would form the basis of some exceedingly interesting literature. The liquid products of distillation, for many years discarded as useless, have, under the revealing eye of scientific investigation, given us the coal tar dyes. Similarly, naphthalene, formerly a waste product of the same process, produces indigo. Creosote, tar and pitch, better known to the engineer than the others, are each a manifestation of scientific research.

These widely known instances in the development of industry, as well as innumerable revelations of a similar nature, preach excellent sermons. They did not happen by chance. The scientist, with his training in exactness, and his consequent elasticity of mind, brought them about, and established the laws governing their manufacture. They were the reward of most careful vigilance—nothing being allowed to escape unnoticed or uninvestigated.

The question is: Are we in our own Canadian industries keeping our various processes under the trained eye of the student of Science? Do we employ him in our shops and factories to study the effects of the forces that are at work there, and the quality of the materials upon which they operate?

This is being done in European countries and in the United States. To these countries are going many of the men whom our Canadian universities are training to apply Science to Industry.

UNIVERSITY INSTRUCTION IN HIGHWAY ENGINEERING.

Apart from the general course of training in the principles of civil engineering as presented in our Canadian universities and colleges, it is interesting to note the response which many of them have tendered to meet the demand for a special training in matters pertaining directly to road and pavement work. Undoubtedly this adaptation, requiring in several incidents an amendment of policy, has been occasioned by the disturbance which motor-driven vehicles have caused in the hitherto well-established art of road-making. This problem, together

with the increasing demand for facilities of transportation, which has made itself heard in various portions of the country, has precipitated an enormous demand for scientific instruction. The elementary principles upon which the practice of road-making and maintenance had long been based, had, to a certain extent, given place to a set of rules, broad enough in scope to be applicable to the average problem which, in previous years, had only to contend with horse-drawn traffic. The automobile, in conjunction with the steel tire and horse's hoof, has sent us back to elementary principles with respect to many things, and the co-operation of the universities in an endeavor to solve the road problem of the present day is timely and worthy of strong support.

A few years ago the University of Toronto established a course in highway engineering, optional to students of the fourth year in the department of civil engineering. It consists of a course of lectures and laboratory work of two hours and six hours per week respectively, throughout the entire session. The course deals with the design and construction of roads and pavements and careful analyses and tests of materials, their characteristics, durability and strength.

In McGill University instruction in this branch consists of a brief course of lectures on city pavements in connection with the third year work in municipal engineering. The topics taken up include methods of construction, cost, durability and desirability of various kinds of pavements; grades and cross-sections; methods of assessment of costs, and methods of maintenance and cleaning. There is no laboratory course devoted specifically to road materials, but there are those in the tests of cement and concrete, as well as a very thorough course in the design of bridges for highways and railways. It is intended to increase the instruction now given by a course of 26 lectures and 26 laboratory periods; and also to install equipment for standard tests of materials.

At the Ecole Polytechnique, Laval University, regular lectures on the subject of highway engineering have been given for the last 20 years, the course covering all matters pertaining to road-making and street pavements. Several years ago a laboratory was installed for the testing of paving materials. These tests include impacts, abrasion, hardness, toughness, cementation, absorption, specific gravity and fracture in connection with materials used for paving and macadam. The department is also equipped for the testing of bitumens, asphalts, tars and oils, as well as other compounds used in surfacing macadam. The course of lectures includes those on legislation relating to roads and streets.

For the past five years in the department of civil engineering in the School of Mining, Queen's University, there has been a course in municipal engineering in which one hour per week and approximately 25 hours per session have been devoted to highway work. A revision of the curriculum this year adds to this an hour per week in the third year devoted to municipal engineering, in which case one-half the lectures will be taken up with highway work.

The third year students in civil engineering and forestry in the University of New Brunswick have a course of about 25 lectures in highway construction. With the exception of cement testing, no laboratory work has been given in this connection. The department of agricultural engineering in the University of Saskatchewan includes highway construction in its third year course. In addition a portion of a short course for farmers which this university provides was devoted this year to a series of lectures on road construction by Mr. H. S. Carpenter, chief engineer to the Highway Commission for the Province of Saskatchewan.

Students in civil engineering at the University of Manitoba receive a lecture course of two hours per week for one term in highway construction. There is under contemplation an extension in the near future to include laboratory work as well as the study and inspection of the various materials used in road-making.

The University of Alberta has no distinctive course in highway engineering except as part of the course in municipal engineering.

The University of Mt. Allison College, through its affiliation with McGill University and Nova Scotia Technical College and the Ontario Agricultural College, have no courses on the subject, but touch upon it in the lectures of other courses.

SASKATCHEWAN LOCAL GOVERNMENT BOARD.

The extent of local improvement work in the various municipalities in Saskatchewan is shown by the fact that during the four months of existence of the Saskatchewan Local Government Board, debentures for $5,540,752.14 were authorized. Of that amount, school districts received authorization to issue debentures amounting to $689,225; rural telephone companies, $361,400; rural municipalities, $6,000; towns, $289,400; villages, $8,900, and cities, $4,185,827.14. Almost half of the debentures being issued by the seven cities of Saskatchewan are those providing for local improvement works at Regina.

PROPOSED TOWN-PLANNING BILL.

At the forthcoming International Conference on City Planning, Toronto, May 25-27, a draft town-planning act will be submitted to the delegates present by a special committee appointed by the Commission of Conservation. After being amended in accordance with the resolutions of the Conference, copies will be sent to each provincial government, urging them to enact legislation along the lines proposed.

As now drafted, the bill provides for the preparing and carrying out of town-planning projects by a local board in each city or town, subject to the approval of a central town-planning board for the whole province. Projects will apply chiefly to land likely to be used for building purposes, but may, in certain circumstances, include land already built upon or land unsuitable for building. Provision is made for compensation of private owners if injuriously affected and for the local authority recovering half of the unearned increment if property values are increased. The central board may act on its own initiative if the local board fails to do its duty or if no local board exists.

EDMONTON BRANCH, CAN. SOC. C.E.

On May 1st an Edmonton Branch of the Canadian Society of Civil Engineers was formed, with headquarters at the University of Alberta. Fortnightly meetings will be held. The following are the officers elected for the year: Chairman, W. Muir Edwards, M.Sc., C.E., Professor of Civil Engineering, University of Alberta; secretary-treasurer, L. B. Elliott, Department of Public Works, Canada. Executive Committee—Commissioner of Works, J. Chalmers; W. R. Smith, N. M. Thornton, D. J. Carter, J. D. Robertson, and R. H. Parsons.

NEW INCINERATING PLANT AT REGINA, SASK.

DESCRIPTION OF A 60-TON INCINERATING UNIT RECENTLY ADDED TO PREVIOUS 50-TON UNIT — RESULTS OF TESTS SHOWING COST OF OPERATION UNDER VARYING CONDITIONS.

IN the early part of 1907 Regina decided to erect an incinerating plant to care for the refuse of that city. The contract was let to the Decarie Incinerator Company, of Minneapolis, Minn., and a 50-ton, single unit plant of the steel waterjacketed type was installed at that time. The incinerating furnace proper was constructed entirely of steel 10 ft. square by 12½ ft. high, inside dimensions, with a 4-in. water space on all four sides and with a 2-ft. steam and water space above the crown sheet. Along two sides of the furnace were placed 1½-in. extra heavy pipes connected to the crown sheet at the top and to the firebox sheets at the bottom. The pipes were spaced at 9-in. centres and bent so as to form a basket grate to receive the refuse which was charged in from the wagons on the floor above through four 3-ft. square hopper openings in the crown sheet. By this means the refuse was lodged upon an indestructible grate about 3 ft. above the lower or cast iron shaking grates on which the material was finally consumed, giving the fire free access to all parts of the newly charged material, without in any way obstructing the draft or deadening the fire below.

This 50-ton unit was installed in a brick building with wooden driveways to the upper floor, enabling the refuse

Fig. 1.—Exterior View of Plant.

wagons to deposit their loads directly into the furnace. Nothing but natural draft was provided and that was furnished by a steel stack 135 ft. high and 4 ft. diameter at the top.

At that time it was thought that a plant of 50 tons daily capacity would be amply large for several years to come; but the phenomenal growth of the city during the past few years made it plain, late in 1912, that in a short time the plant would need to have additional capacity. Consequently, steps were immediately taken by the city commissioners, through Dr. M. R. Bow, medical health officer, and Mr. J. A. Bertwistle, chief sanitary inspector of the city, to outline a larger refuse disposal system of sufficient size to care for the city in the future. Regina

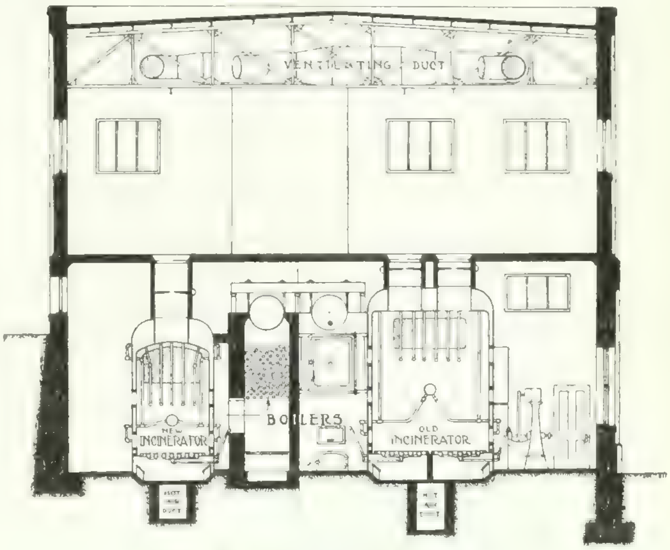

Fig. 2.—Cross-section of Plant.

already had under construction additions to their 2½-million-gallon sewage disposal plant, which is located in the extreme northwestern portion of the city on the banks of Wascana Creek. The pumps to be installed here were to be electrically operated, and immediately the question arose as to the advisability of utilizing the heat generated by the burning refuse to help furnish the power for operating these pumps. It was known that the heat from a city's refuse is converted into electrical energy in many European cities and used to produce a source of revenue. It was also known that the incinerating plant built by the Decarie Incinerator Company, at Minneapolis, had for years been furnishing the power to light several wards of the city. Consequently, it was decided to investigate the feasibility of such an arrangement in connection with the sewage plant.

This company agreed to construct a modern plant at the site of the sewage disposal works for the sum of $64,000. The plant was to consist of a new 60-ton unit, with the old 50-ton unit, which had operated very satisfactorily during the past 5 years, renovated and moved into the same building, making in all a plant with a guaranteed capacity of 110 tons in 24 hours. The plant was to be equipped with two 100-h.p. B. & W. water tube boilers, together with forced and induced mechanical draft.

In May, 1913, the contract was awarded to the Decarie Incinerator Company at the above figure. On December 1st, 1913, the new plant commenced operation.

The terms of the proposal as furnished by the contractors to the city were:—

"The new unit to be installed should have a capacity of incinerating 60 tons of refuse in 24 hours and the old unit, after being remodelled and installed in the new plant, should have a capacity of incinerating 50 tons of refuse in 24 hours. The refuse to consist of kitchen garbage, combustible material, manure and dead animals mixed together in proportions as created by the city of Regina from day to day, no attention being paid as to the selection of any particular kind of refuse or garbage; it being understood that manure would constitute 60% of the refuse to be destroyed.

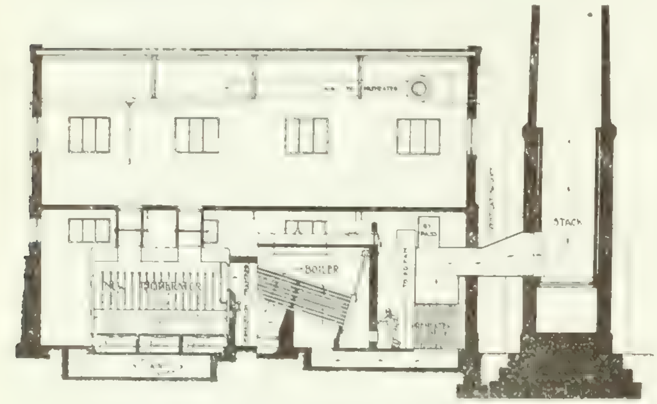

Fig. 3.—Longitudinal Section.

"All material delivered to the incinerator would be destroyed without creating any noxious odors or gases.

"The total cost of operation would not exceed 65c. per ton, and if credit would be given for power developed by the boilers, at the rate of 70c. per 1,000 lb. of steam, the cost would be reduced by one-half, and if 30% of the total refuse should be dry combustible the addition of fuel would be unnecessary."

The guaranteed cost of operation is claimed to be somewhat higher than usual, owing to the large percentage of manure that had to be handled. According to the results of the final tests, as given in this article, however, the operating cost came to only 40c. per ton when burning 60% of manure. The old plant had a guaranteed cost of 50c. per ton and operated at an average of 30c. per ton for the five years previous; but, of course, it handled no such percentage of manure as the new plant was required to dispose of. In fact, in the old plant the city had difficulty in consuming the manure without additional fuel, as this plant was equipped with no mechanical draft whatever.

The new plant is located on the bank of Wascana Creek, the building being of concrete, brick and steel construction 44 ft. x 54 ft., inside dimensions. Two sides of the first floor of the building were formed by the concrete retaining walls. As shown in Fig. 1, the remainder of the building is of brick. The hopper or charging floor is of reinforced concrete supported on steel beams. The standard gauge street car track, on which the refuse is delivered to the plant in special dump-cars, passes through the building at the hopper floor level. The roof is of 3-in. concrete slab construction covered with tar and gravel roofing, supported on steel purlins and trusses. I-beam trolley tracks are attached to the under side of the trusses over each unit, on which chain blocks operate to raise the heavy cast iron hopper covers and carcasses that are brought to the plant for destruction.

All material as it is delivered to the plant is dumped directly into the furnaces from the cars, without storage of the refuse being necessary. Drain connections to the sewer as well as water and steam connections are provided on the charging floor for keeping the cars and the floor in a sanitary condition.

The incinerating furnaces and boilers, together with all the other necessary machinery, are located on the lower or operating floor, the general arrangement being as shown in Figs. 3 and 4. The two separate units are of 60 and 50 tons capacity, as stated above. Each unit consists of an incinerator, combustion chamber, and one 100-h.p. B. & W. boiler. A pre-heater or regenerator for heating the forced draft is located between the boilers and the chimney. An American Blower Company's induced draft-fan, direct connected to an 11-in. x 8-in. automatic high-speed self-oiling steam engine is provided, as well as a forced draft-fan of the same make direct connected to a 9-in. x 7-in. steam engine of similar construction. Four $5\frac{1}{2}$ x $3\frac{1}{2}$ x 6 Marsh feed pumps are provided; one for each incinerator and one for each boiler.

The chimney is 5 ft. in diam. at the top and 125 ft. high. It is of radial brick construction with an octagonal common brick base, set on a heavy concrete foundation just outside the building wall.

The new incinerator is of the waterjacketed type which had proved itself so economical in repairs and operation in the old 50-ton plant. As can be noted from Figs. 2, 3 and 5, it is made with larger and narrower dimensions than the old unit; being 6 ft. wide by 18 ft. long, and is 10 ft. high, inside dimensions. It has 4-in. water legs and a 2-ft. steam and water space above the crown sheet. With these proportions the labor necessary for stoking is materially reduced, and as the number of stoking doors is much smaller, not nearly so much cold air is drawn into the furnace. As will be noted from the two sectional views, the piping forming the basket-grates in both the new and old units is of the latest construction used in this make of furnace.

The longitudinal header, connecting the two end water spaces and into which all the 2-in. basket pipes are

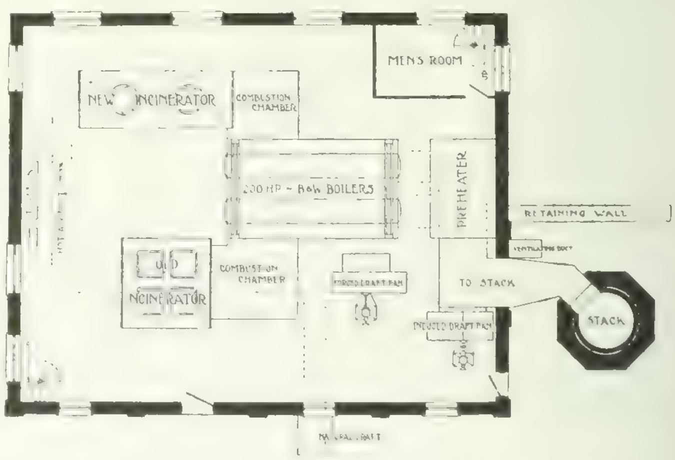

Fig. 4.—Plan of Operating Floor.

connected at their lower ends, is made of 12-in. extra heavy pipe in the new incinerator and 8-in. extra heavy pipe in the old one. As will also be noted from the sectional illustrations, the pipes forming the basket grate do not connect into the inside plates but come through the water-leg and, by means of union tees and elbows, connect into the outside sheets. This arrangement enables

these pipes to be kept thoroughly clean by means of plugs located in the tees.

Operation.—The refuse enters from the upper floor through the balanced doors in the brick-lined hoppers and drops onto the basket grate. As it burns in this position, and on the shaking grates directly beneath, the gases pass into each respective brick-lined steel-cased combustion chamber, where they are thoroughly mixed and burned before entering the boilers through the side wall directly over the boiler grates. The gases then pass through the water tubes of the boiler, giving up a large amount of their heat to the generation of steam in these tubes. It will be noted here that by this arrangement the boilers can be operated simultaneously with the waste gases and with coal in case the heat from the refuse is not sufficient to maintain a constant pressure, conditions being liable to occur in wet weather or when the heat value of the refuse is exceptionally low.

After leaving the boilers the gases pass under the floor and up through the pre-heater, or regenerator, direct to the chimney; or they may be drawn through the induced draft fan to the chimney, as the conditions may require.

hindering the operation of the other sections of the grate. The use of this hot forced draft has shown itself to be the most essential feature in the burning of manure and saving of additional fuel. In case only natural draft is used, as in starting up when the steam pressure is down, an opening is provided to the outside of the building so that air can be drawn directly into the ash pit, thereby removing the necessity of opening the ash pit doors. This feature is especially valuable in the winter time when the lower floor is well sealed up to prevent the cold air from coming into the building.

Each unit is also provided with a by-pass direct from the respective combustion chambers to the chimney, thereby enabling the boilers and pre-heater to be entirely cut out in case, for any reason, repairs should be necessary, or if occasion should arise, the boilers and incinerators can be operated entirely independent of each other.

The boilers are installed to work at a pressure of 160 lbs. per sq. in., the plan being to use the steam from the boilers for the generation of electric current for the sewage pumps. The generator set has not yet been installed, but very likely will be in the near future.

Fig. 5.—Interior View, Showing New Incinerator, Boilers and Pumps.

Fig. 6.—Forced Draft and Induced Draft Fan Installation.

The one pre-heater and the induced draft fan serves for both units or for either one of the two units if only one unit is in operation. The pre-heater contains 740 2½-in. boiler tubes expanded into ⅜-in. steel plate heads, the gases passing through these tubes on their way to the stack. The air supply for the forced draft fan is taken through a duct leading from the ceiling of the upper floor to the pre-heater, thus removing all the foul air from the building that might come from the refuse as delivered. This air is drawn through the pre-heater around the tubes through which the hot gases are passing, taking up enough of this heat from the waste gases to raise the temperature of the air going into the forced draft fan to the temperature of from 150° to 400° F. The forced draft fan forces this heated air through concrete ducts below the floor, as indicated in Fig. 4, to the ash pits of the two incinerators. It enters the pits directly under the grates through suitable control nozzles at a maximum pressure of 4½ inches. It might be stated here that the ash pits of each incinerator are divided into sections, so that the forced draft can be shut off entirely in any one section and the fire cleaned on that section of grates without

The incinerators are designed to operate at 100 lbs. per sq. in. steam pressure, but in the continuous operation of the plant as a steam generating station each incinerator operates as a feed water heater for its respective boiler, the fans being operated by the steam from the boilers. The piping is arranged so that in starting up the plant, or, when the boilers are shut down, the incinerators can furnish the necessary steam for the fans and pumps.

The blow-offs from the incinerators lead into the respective combustion chambers and those from the boilers lead to the atmosphere through a 5-in. pipe. The exhausts from the pumps and fan engines pass through a 6-in. pipe directly into the base of the chimney.

The installation of the complete equipment, except the old incinerator itself, was completed and the plant commenced operation December 1st, 1913. It was agreed by the city that a test of the capacity of the 60-ton unit would determine the fulfilment of the guarantees, as the city could not, without great inconvenience, supply more than 60 tons of refuse in 24 hours. The 50-ton unit could

not be dismantled at the old plant until the new plant was in operation and consequently the installation of the old unit in the new plant has just recently been completed after it has been overhauled and equipped with the new system of piping.

Near the site of the street car barns, the city has erected a loading station and a stable.* It is here that collection wagons deliver their loads of refuse into the dump-cars.

The loading station is a brick and reinforced concrete building, two stories high, 46 ft. x 146 ft., and was erected at a cost of $16,000. A siding of the municipal street railway runs through the building at ground level, and in this siding are placed the 5-yd. steel dump-cars especially designed for this service. The loaded collection wagons enter on the second floor by means of an approach at the end of the building and dump their contents directly into the cars. At present it is only necessary to make one trip per day to the plant with the loaded train of cars, as the storage capacity of the empty cars is enough to hold the city's daily amount of refuse at this season of the year.

The stable is also of brick construction, erected at a cost of $23,000, and provided with single stalls for 32 teams, together with 4 box stalls. The wagons are housed under the second floor of the loading station.

The first of the three test periods held on the new plant occurred on December 1, 1913, under the supervision of the builders, with the following results:—

Date of test	December 1st, 1913.
Duration of test	22 hours.
Grate area	108 square feet.
Material incinerated	Manure, 57,240 lbs. Garbage, 55,480 " Fruit, 2,800 " Fish, 3,500 " Horses, 1,500 "
Total material destroyed	60.26 tons.
Percentage of manure	47.5 per cent.
Percentage of ash	10.0 per cent.
Refuse burned per hour	2.74 tons.
Equiv. incineration in 24 hrs.	65.76 tons.
Equiv. incineration per sq. ft. grate	50.7 per cwt.
Labor required	1 engineer 22 hrs. at 50 cents ... $11.00 3 firemen 22 hrs. each at 30 cents . 19.80 $30.80
Labor cost per ton	51.1 cents.
Fuel required	Coal, 200 pounds. Kindling, ¼ cord ... $3.00
Total cost of fuel	$3.00.
Fuel cost per ton refuse	.049 cents.
Total cost of operation per ton refuse	.56 cents.

Although this first test fulfilled all the guarantees of the builders, the city desired to run another test with the regular city crew operating the plant. They also desired to have the requisite quantity of manure on hand to make up the 60% that was stipulated in the contract. Consequently, on December 12, 1913, a second test was run with the city's crew operating the fires, the following results being obtained:

Date of test	December 12th, 1913.
Duration of test	9.5 hours.
Grate area	108 square feet.
Material incinerated	Manure ....23,310 lbs. Garbage and refuse.24,460 " 47,770 lbs.
Total material destroyed	23.89 tons.
Percentage of manure	48.8 per cent.
Percentage of ash	10.0 per cent.
Refuse burned per hour	2.51 tons.
Equiv. incineration in 24 hrs.	60.24 tons.
Refuse burned per sq. ft. grate per hour	46.5 lbs.
Labor required	1 engineer 9½ hrs. at 50 cents .... $4.75 3 firemen 9½ hrs each at 25 cents 7.12 $11.87
Labor cost per ton	49.7 cents.
Fuel required	No coal used. Small amount kindling wood to start.
Total cost fuel required	0.50 cents.
Total cost per ton refuse	2.1 cents.
Total cost operation, per ton.	51.8 cents.

The plant demonstrated in this second test, also, that it could be operated within the guaranteed cost by the city's own men, but again the 60% of manure was not available. Consequently, a third and final test was held on January 7, 1914, the results being as follows:—

Date of test	January 7-8th, 1914.
Duration of test	19.0 hours.
Grate area	108 square feet.
Material incinerated	Garbage and refuse.48,870 lbs. Manure ......74,100 " 122,970 lbs.
Total material destroyed	61.49 tons.
Percentage of manure	60.3 per cent.
Percentage of ash	10 per cent.
Refuse burned per hour	3.24 tons.
Equiv. incineration in 24 hrs.	77.76 tons.
Refuse burned per sq. ft. grate per hour	60.0 lbs.
Labor required	1 engineer 19 hrs. at 50 cents .... $ 9.50 2 firemen 19 hrs. each at 25 cents 9.50 $19.00
Labor cost per ton	30.9 cents.
Fuel required	½ cord wood, $4. 200 lbs. coal, $1.
Total cost fuel required	$5.00.
Fuel cost per ton refuse	8.1 cents.
Total cost operation per ton refuse.	39.0 cents.

On April 23 a report was made by John A. Penton of Cleveland, secretary of the American Pig Iron Association, to the general assembly of the association held at New York. The report showed that the pig iron industry in the United States is being operated at a loss of $1,000,000 a month. It further declared that the average loss on all pig iron sold by 85 per cent. of the pig iron manufacturers and merchants north of the Ohio River during February last was $1.15 per ton. Unfilled orders on the books of the members of the association on March 1 amounted to 1,714,801 tons; and as a result of these conditions, many furnaces have been shut down and plants are in the hands of receivers.

As a result of the building of the Assouan Dam on the Nile, the primary object of which was to conserve water for irrigation purposes, the development of 5,000 horsepower in the form of electrical energy has been made possible. Different purposes to which this power can be applied are being considered. One horsepower will manufacture two tons of calcium cyanamide in one year, and thus the Assouan power could turn out 100,000 tons per annum—that is to say, £900,000 worth of the fertilizing agent most extensively required in Egypt. Another use the power could be put to, as shown by Sir William Willcocks' recent work, is summer irrigation, on an even more extensive scale than at present provided for. It is also proposed to utilize the power in the weaving of silk

THE HIGHWAY SITUATION IN ONTARIO.

THE proposals for preliminary organization and investigation, made in the recent report of the Public Roads and Highways Commission, are very deserving of the attention of road officials, not only of Ontario but throughout the Dominion. The commission, consisting of Messrs. McLean, Rankin and McGrath, chairman, was appointed on July 31st, 1913, to make a preliminary survey of the immense problem in the province of Ontario and to lay down a set of proposals. Their report contains the result of their investigations, together with a number of considerations and suggestions of considerable importance.

Their suggestion is that the province embark upon a definite 15 years' policy, and establish a form of organization carefully designed to be simple and flexible, and to fit itself into the developments of the future. The work to be done, they conceive, should be of a permanent character, but as permanent roadways are constructed, proper measures should be taken to ensure efficient maintenance, and the expenditure on maintenance must grow as a service of this sort is built up. The method to be pursued is the fixing of a certain scale of expenditure during the prescribed period; the devoting of a portion of that sum to the raising of a bond issue whereby considerable capital sums could be obtained at once for permanent work; and the extinguishing of these bonds at a fairly rapid rate, so that they shall not outlast the roads which they will represent. The total capital expenditure which they propose for this period is $30,000,000, the securities to be issued in instalments as the growing organization is able profitably to spend the money. Allowing for interest and sinking fund outlays, they estimate the annual expenditure upon permanent roadways towards the close of the period at approximately $2,500,000. This would be, roughly, at the rate of $1 per head for the population of the province, or about the payment per head in France for the maintenance of a superb system of highways. The money should be raised from various sources—province, counties, cities and towns, and should be expended by various bodies, a cardinal principle being that the people themselves should be as close to the expenditure and the responsibility as possible.

For the expending of this sum of money, and the conduct of so important, so continuous, and so technical an undertaking, a permanent administrative body is necessary. It should be under a minister of the Crown, and under him should be a permanent head for the administrative work which will be inevitable. A chief engineer will be necessary, for a high quality of skilled and scientific work is demanded if the enterprise is to be economically and successfully undertaken. In addition, there is scope for an unpaid advisory commission—comprising three men of affairs, their function being to consult with the permanent head, chief engineer, and minister, on technical (as distinguished from general) policy, and to assist in interesting the general public in a project which every citizen should regard as his own affair.

The commissioners are of opinion that a satisfactory organization cannot be ready before 1915, and that the coming season should be devoted to a rapid preliminary study of physical conditions. The actual mileage of the roads has been ascertained, but less is known upon the all-important subject of the available supplies of road-building material The nucleus of the central organization, and the permanent advisory commission, if appointed, might with profit prosecute the following lines of investigation:—

(1) A motor survey of the main-travelled roads; parties suitably composed might traverse these roads and form an estimate of their present condition and the amount and kind of work necessary to bring them up to a satisfactory standard.

(2) A study of the township roads prosecuted by selected engineers, to determine the condition of the more important ones, with a view to their improvement.

(3) A traffic census, designed to give fairly exact information as to the volume of traffic now borne by the highways.

(4) A study of the market roads in counties not now under the Highway Act, with a view to suggesting to each of such municipalities a suitable system of market roads.

(5) A determination of equitable suburban areas for each city, as suggested herein.

(6) A survey of the proposed Toronto-Hamilton and Ottawa-St. Lawrence roads; and certain investigations of the Queenston-Hamilton or other roads of a similar character.

The report sets forth the views of the commission upon the subject of the classification of roads. The general classification of roads and their division into groups for control are matters of primary importance in dealing with public highways. The cost of construction and maintenance, and the methods to be applied, are largely in proportion to the amount of traffic on the several roads; and an intelligent classification is basic, in apportioning the cost fairly, and in providing for efficient methods of construction and finance.

The province of Ontario may be divided as follows:

(a) Well settled areas, about	30,000	sq. miles
(b) Areas containing scattered settlements, or at present available for settlement, about	30,000	"
(c) Areas likely to remain for many years in a state of nature, but containing wealth in the form of timber, minerals, fisheries, and fur-bearing animals, about	200,000	"
Total area	260,000	"

The area of England and Wales, with a population of over 36,000,000, is under 60,000 square miles. Thus the settled area in Ontario, whose road system is the subject of the present inquiry, is about one-half that of England and Wales, and the total area whose equipment with roads is a prospect of a measurably near future, is about the same as that of England and Wales.

The closely settled area of Ontario at present is traversed by about 50,000 miles of roads, and in addition there are colonization roads, which the Provincial Government builds in the newer districts to encourage settlement, and often in advance of it. These colonization roads raise a set of problems so diverse from those of the highways of the settled portions of the country that your commissioners do not recommend that they be detached from the organization now in charge of them, and they shall henceforth omit them from the purview of this report. Their main concern is with the 50,000 miles of roadways in the 30,000 square miles of the settled and organized portion of the province.

The highways of Ontario seem to fall into the following sub-divisions:

County or Market Roads.—These fall into the following subdivisions:

(a) Suburban Roads.—These are close to the cities, and have to bear perhaps the heaviest traffic of any rural highways; partly because some of them are used for interurban traffic, partly because of the traffic created in a belt about the city by the propinquity and the demands of its great consuming population. Often the farmers living in these belts are in a sense citizens of the towns whose market they supply, and whose shops they frequent. The cities are specially interested in the roads of this class, which have a direct bearing upon the food prices which prevail in them, and upon the comfort of their citizens.

(b) Interurban Roads.—These are main travelled highways between centres of population, and are subjected to considerable use by persons other than farmers.

(c) Rural Market Roads.—These are main travelled highways used mainly by farmers on their way to the centres where they buy and sell, but used by many whose properties do not border them. Often many of the township roads to be noticed in a moment discharge their traffic into these small arteries of local traffic. It is a function of these roads to lace together the various townships and rural communities.

Township Roads.—These constitute the vast mass of the roads of the countryside; they serve mainly the farmers who live alongside them, and for the most part lead into main travelled or market highways.

In the present circumstances, the general condition of rural roads being so indifferent, interurban and market routes have a tendency to shift; as one stretch of road is improved or another allowed to deteriorate, so that the volume of traffic borne by a particular route is not an absolute proof that under a proper organization of the road system of the province, it would not be a main travelled road. A road census would show what amount of travel is furnished to-day by a given district, and the channels which it now takes; but considerations such as the density of population, the productivity of the land, railway construction, possible or probable developments, the distribution of road making material, and so forth, would have to be taken into account.

One such consideration is the possibility of future urban growth which will lead to the places concerned sending out and attracting to themselves a greatly increased volume of traffic; should this occur, the place so developing would need additional market and interurban routes, striking out from it at varying angles, and in some cases cutting diagonally across the present rectangular road-patterns. It is suggested that tentative plans for such diagonal roads be drawn up with regard to certain prominent centres, and some arrangement—such as the prohibition of the erection of buildings in their track—be made to ensure the possibility of their being constructed at the lowest possible cost, if need should arise in the future.

It is the opinion of the commissioners that if due care is taken in studying the situation, the county roads, those taking care of the heavy non-local traffic, need not greatly exceed 15% of the whole. Thus they view the problem as that of bringing 42,500 miles of township roads to a reasonably fair standard, and of fitting 7,500 miles of county roads to bear the severe demands made upon them.

County Roads.—The cost of the county roads is bound to be considerable. Until the advent of the high-speed motor, the art of road-building had been in a fairly settled condition, but the new vehicles had thrown it back into an experimental stage. The problem is rendered the more difficult by the fact that motors and horse-drawn vehicles use the same roadways, with destructive effect; for the narrow tires of heavy wagons grind the stone to dust, and keep the road in a condition in which the shearing effect of rubber tires of the motor is most severely felt. Thus certain types of roads which would withstand motor traffic alone, fail when used by both types of vehicle. The practical effect of this condition is that the cost of roads exposed to heavy traffic is increasing.

The report makes the following recommendations with regard to the treatment of these roads, which are subject to specially heavy traffic:

(1) With regard to suburban roads, the selection of roads to be regarded as such should lie with the province; the various interests affected should, of course, be heard. The control of the construction and the subsequent maintenance should be committed to boards of trustees, on which the city and the county should be represented.

With regard to the financial measures necessary to construct and maintain these special roads, they suggest that the annual support given by the cities should not exceed a rate of three-quarters of a mill. The funds provided by the cities should be expended solely on roads within their own suburban areas. The proportions of cost to be borne by the several parties concerned in these roads should be as follows:

The city	30%
The county	30%
The province	40%

Should the cost exceed $10,000 a mile, the excess should be levied as a local improvement tax.

(2) The treatment of interurban roads may be noticed. Within suburban areas, these roads should be treated as suburban roads. Once outside the suburban belt, the cost of construction might be divided into three equal portions among the province, the county, and the motor vehicles, and as the province is the recipient of motor fees, its proportion might be two-thirds up to a total average cost of $12,000 per mile.

With respect to the distribution of the cost of maintenance, the commissioners recommend that in the case of suburban roads, the city, the county, and the province should each contribute a third. In the case of the interurban roads outside of suburban areas, they recommend that the county contribute sixty per cent. and the province forty per cent.

As regards county rural roads, the control should rest with the county council, or in a permanent commission to be selected by that body. As regards the cost alike to construction and maintenance, the division proposed is sixty per cent. to be borne by the county and forty per cent. by the province.

Township Roads.—An opinion which finds influential backing is that a vast amount of energy is wasted on these roads through the dumping of earth on the roadway to be quickly washed away during the usual wet season. Therefore, these township roads need attention. There are 426 organized townships in the province, with a total assessment in 1912 of $604,737,037. The average rate for roads and bridges of this class is about $1,500,000 annually.

It is held that the control of such roads, and the work of construction and supervision must rest as at present, entirely with local township councils. It nevertheless seems highly important that some assistance should be extended to those townships, as the welfare of the province demands that a heavy percentage of their rural roads should be brought up as quickly as possible to a fair standard as earth roads; and it is felt that to accomplish

this, some provision for stimulating local interest and directing local endeavor along channels in which it will prove most effective should be made.

The new highways organization should be specially charged to give attention to main township roads. Provincial support meanwhile might be limited to three years, when the department would be in a better position to bring forward some plan for rapidly bringing these roads up to meet the business needs of the people.

It is proposed that the aid should not be given to townships until the county has assumed a system of market roads; otherwise, as alternative plans, they might seriously interfere with the installation of a proper system of such county roads. It is felt that provision for a system of good market roads in each county is of first importance and that aid to townships should not be in any way allowed to take the place of such roads. Aided county and township roads are designed to be complementary parts in a general scheme; and aid to local roads should be for the purpose of encouraging their improvement as feeders to the market lines of more general use.

As a tentative plan, it is suggested that the province be prepared to provide $250,000 annually for three years, which is about 20% of two mills on the total assessment of about $604,000,000, or between 15 and 20% of the present cash expenditure by townships on their roads. The apportionment of the aid might be effected in various ways. One would be to make it on basis of population; another would be to make it on the basis of assessment. A third, which would be of special benefit to the weaker municipalities, would be $50,000, $50,000 and $150,000, to be distributed proportionally on a basis of assessment, population and area, respectively.

A plan of assistance which has been suggested is that short-term loans without interest might be granted to townships by the government for road purposes.

In each case the grant should depend upon the observance of certain conditions, such as:

(1) Each township should spend at least $4 on its township roads for every dollar to be contributed by the government.

(2) Proper drainage should be installed for each stretch of roadway aided.

(3) Statute labor should be abolished or commuted.

(4) The roads should be dragged.

(5) A proper township road organization should be established.

The establishment of an efficient organization is vital, and the most essential feature of such an organization is one township foreman in charge of road work displacing all other pathmasters and commissioners and retained as permanently as a township clerk or treasurer.

Little progress can be expected from township expenditure until it is put in charge of permanent road foremen, who, by their growing experience and constant attention, can bring system, uniformity, and continuity into the work.

In addition, therefore, to the actual improvement that would be accomplished by the expenditure suggested, it is felt that the educational value of the methods of road-building upon which the province could insist would be great, and that once the value of such methods could in this practical way be exemplified in a community, there would be little desire to return to the less effective methods at present generally in use.

With respect to the taxation of motor vehicles the commissioners recommended the following scheme:

(1) Automobiles:	
Horse-power (brake)	Registration fee.
Up to 20	$10.00 per car
21 to 30	50 per h.p.
31 to 40	60 per h.p.
41 to 56	75 per h.p.
Over 56	1.00 per h.p.
(2) Commercial Trucks:	
2 tons and less	10.00 per car
Over 2 tons	5.00 per ton
(3) Motor cycles	4.00
(4) Chauffeurs	4.00
(5) Foreign tourists	10.00 (uniformly)
(6) Foreign trucks	10.00 (uniformly)

The above figures applied to Ontario motors, etc., would yield about	$400,000
New York fees applied to Ontario motors would yield about	101,340
New Hampshire fees applied to Ontario motors would yield about	658,115
Great Britain fees applied to Ontario motors would yield about	658,115
Italy fees applied to Ontario motors would yield about	844,129

It is understood that the New York fees may be increased.

In proposing these rates of taxation, the commissioners decline to take the view that the motor tax should be levied as a punitive measure, on the ground that these machines are the chief agency in the destruction of the roads. For one reason, horse-drawn vehicles also use the roads, and in some cases contribute the sort of wear which causes the motors to be destructive; there are certain types of roads which would give fair satisfaction if their use was confined to motors, but which deteriorate rapidly when the narrow-tyred wagon abrades their surface in such a way as to give the clutching wheel of the motor car the excavating effect which the road-builders dread. For another, if the principle of grading the taxation, according to the individual's use of the roads were accepted, it might be urged that the contributors of taxes to the upkeep of schools should be those whose children attend, and those alone; and on a per capita basis, regardless of the varying ability of the taxpayers to contribute.

Summary of Recommendations.—The recommendations of the commission may be briefly summarized as follows:—

1. The committing of the actual control and management of the roads, so far as possible, to local bodies—the county councils, or commissions appointed by them, boards of trustees, etc.

2. The blocking out of a definite amount of work to be begun in 1915, and to be completed about 1930. Cities should contribute at least to the construction and upkeep of the roads in their immediate neighborhood. The permanent construction work should be regarded as a capital expenditure, and should be financed by bond issues designed to reach by 1930 a total sum of about $30,000,000, apportioned as follows:

To the province (including the capitalization of some of the revenue from motor fees)	$12,000,000
To the counties	12,000,000
To the cities	6,000,000

3. The provision for proper maintenance for every mile of permanent road work, the funds for this to be obtained from current revenues.

4. The devoting of special attention to the improvement of township roads.

5. The putting of taxation of motor vehicles on a systematic basis, which your commission estimate would produce about $400,000 in the earlier years.

The development of a central highways department under the headship of a minister of the Crown, with its permanent principal officials, a deputy minister and a chief engineer, and in addition an unpaid advisory commission of men with a genius for accomplishing big things.

Work on County Roads During 1914.—In view of the impossibility of installing a new plan of road development as outlined in the report before 1915, the commission advises that:

1. Counties now operating under the Highway Act should be encouraged to continue as usual their road work this coming summer, and that the regulations under the Act should be made as elastic as possible so as to allow the other counties to begin work and thereby take advantage of the aid thereunder.

2. There should be created a sufficient organization to carry on this summer the following investigations:

(*a*) A motor survey of principal roads to determine their physical condition.

(*b*) A traffic census to determine the present road needs of the province.

(*c*) An investigation of main township road conditions.

(*d*) An investigation of the Hamilton-Toronto, and Ottawa-St. Lawrence roads, obtaining plans and specifications of same.

(*e*) An investigation designed to outline a plan of market roads for counties not now operating under the Highway Act.

(*f*) A determination of suburban areas about principal centres.

COST OF COMPLETION OF C.N.R.

In regard to the proposed bond guarantee of $45,000,000 to the Canadian Northern Railway, the following engineers' estimate of the amount necessary for the completion of the system is given:—

	Required for construction.	For betterments.
Canadian Northern Pacific	$23,647,402	....
Canadian Northern Alberta	542,959	....
Canadian North-Western	310,088	$ 45,000
Canadian Northern Railway	5,402,712	8,005,000
Canadian Northern Saskatchewan	457,849	....
Canadian Northern Ontario	11,645,467	830,000
Irondale, Bancroft	....	....
Central Ontario	....	....
Bay of Quinte	....	....
Brockville and Westport	....	....
Canadian Northern Quebec	....	870,000
Quebec, Lake St. John	....	175,000
Halifax and S.W.	....	....
Duluth, Winnipeg Pacific	....	....
Total construction	$41,987,465	$10,000,000

The statement shows in addition sub-contractors' accounts not included in the above amounting to $8,348,290 in Western lines, and $6,606,424 in Eastern lines. The estimate of rolling stock required is placed at $27,441,086, plus $10,000,000 for betterments, making a total under these three heads of $100,379,099.

Against this amount there is a sum of $58,473,982, being proceeds of securities earned or available, leaving a balance of $41,905,117.

THE PAVING OUTLOOK FOR 1914.

ALTHOUGH many cities have not set out upon a definite plan of paving operations for the present season, *The Canadian Engineer* has received from a number of them an approximate estimate of the work under contemplation. The figures thus derived are presented herewith, the quantities in each case being given in square yards:—

Belleville, Ont.—Concrete, 18,000; gravel, 10,000; macadam, 25,000.

Berlin, Ont.—Bitulithic, 1,300; bituminous macadam, 22,000; treated wood block, 21,000.

Brandon, Man.—Asphalt block, 20,000; bituminous macadam, 14,000; the former to be contract work, the latter, city day labor.

Brantford, Ont.—Bituminous macadam, 10,000; gravel, 25,000.

Charlottetown, P.E.I.—Macadam, 10,600.

Guelph, Ont.—Bituminous macadam (contract work), 30,000; macadam with tar binder (city day labor), 25,000.

Halifax, N.S.—Bitulithic, or sheet asphalt, 20,000; granite block, 10,000; the latter, city day labor, the former, contract work.

Hamilton, Ont.—Asphaltic concrete, 15,000; bituminous macadam, 10,000; vitrified brick, 4,000; granite block, 1,000; macadam (not bituminous) 200,000; sheet asphalt, 100,000; treated wood block, 20,000; all to be laid by day labor.

Hull, Que.—Asphaltic concrete, 25,000.

Lethbridge, Alta.—Subway and approaches only, 4,300 sq. yds., probably concrete under contract.

London, Ont.—Asphaltic concrete or sheet asphalt, 50,000; vitrified brick, 10,000; concrete, 10,000; gravel, 10,000.

Moncton, N.B.—Bituminous macadam, 20,000; macadam (not bituminous), 15,000.

Montreal, Que.—Bitulithic, 86,000; bituminous macadam, 128,600; sheet asphalt, 300,000; Scoria block, 95,000; stone block, 63,000; treated wood block, 13,200.

New Westminster, B.C.—Asphaltic concrete, 19,200; bitulithic, 23,400.

Niagara Falls, Ont.—Vitrified brick, 62,000; concrete, 12,000, (in both cases city will provide materials but work may be done by contract on percentage basis); macadam (not bituminous), 12,000, to be done by city day labor.

North Vancouver, B.C.—Ordinary macadam, 25,000, to be laid by city.

Ottawa, Ont.—Bituminous macadam, 8,000; sheet asphalt, 100,000; treated wood block, 4,000. The macadam to be laid by city, the remainder under contract.

Peterborough, Ont.—Asphaltic concrete, 35,000; vitrified brick, 11,000; all to be contract work.

Prince Rupert, B.C.—Waterbound macadam, 30,000; plank road, 36,000. The city will lay the former.

St. John, N.B.—Bituminous macadam, 8,000; granite block, 6,000.

Saskatoon, Sask.—Bitulithic, 4,800; stone block, 800; treated wood block, 6,000; all to be contract work.

Sherbrooke, Que. — Ordinary macadam, 10,000; granite or treated wood block, 9,000.

Stratford, Ont.—Asphaltic concrete, 2,000; bituminous macadam, 11,000; vitrified brick, 6,500; concrete,

5,800; all of which, with the possible exception of some of the concrete, will be laid under contract.

Toronto, Ont.—Bitulithic, 78,000; bituminous macadam, 82,000; vitrified brick, 31,700; concrete, 28,000; sheet asphalt, 454,000; treated wood block, 31,000. Tenders will be called on all of this work, the Department of Works submitting a tender as well.

Vancouver, B.C.—Asphaltic concrete, 77,000; bitulithic, 32,500; vitrified brick, 13,500; sheet asphalt, 1,350; treated wood block, 3,000, with the following in track allowance: granite block, 1,800; concrete, 1,825; granitoid, 10,850. All of the pavement will be laid as contract work.

Victoria, B.C.—Sheet asphalt, 95,000. Grading, curb, gutter, and concrete base will be laid by city day labor, and asphalt surfacing by contract.

Westmount, Que.—Bituminous macadam, 900 (city); concrete, 4,800 (city); granite block, 5,500 (contract); sheet asphalt, 20,500 (contract); Scoria block, 3,400 (contract); tar painted macadam, 250 (city).

Winnipeg, Man.—Sheet asphalt, 100,000.

Woodstock, Ont.—Concrete, 1,250; waterbound macadam, 10,500; the former, contract work, the latter by city day labor.

Among the cities whose plans have not been settled might be mentioned Edmonton, whose commissioners have under consideration tenders for 275,000 square yards of street and lane paving with curb and gutter. Moose Jaw is contemplating laying about 20,000 sq. yds. of pavement this year, the type to be chosen subject to bids. Regina proposes to shortly call for tenders for paving, also. Sydney, N.S., is not seriously considering any street paving at present. In 1912 a sum of $100,000 was voted for paving two streets, but the difficulty experienced in the disposal of bonds has delayed the work. No particular type of pavement has been decided upon. It is probable that Medicine Hat, Alta., will lay some permanent pavement this year, but the type or types have not been chosen, nor the quantities fixed. Among the cities that have decided upon no paving program up to the time of writing are Chatham, Ont.; Nelson, B.C.; Port Arthur, Ont.; Portage la Prairie, Man.; Prince Albert, Sask.; Quebec, and St. Hyacinthe, Que.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

On April 30th the mechanical section of the Canadian Society of Civil Engineers was addressed in Montreal by Mr. L. C. Ord, on the Steel Car Shops at Angus. The paper was a splendid description of the shops of the C.P.R. for the construction of steel passenger and freight cars. The design and layout of the freight shop with its 41,785 sq. ft. of floor area, including machine shop, assembling and erecting shops, was dealt with in detail, this section of the plant having been designed chiefly for the construction of steel-frame box cars. The passenger shop was also described, many features of it being similar to those of the freight shop, such, for instance, as the method of handling material, arrangement of machinery and its operation.

The meeting was the closing one of the session.

The statement was made in Winnipeg recently by the president of the Lake of the Woods Milling Company, Colonel Meighen, that that company will spend large sums in Western Canada this year increasing its plant.

Coast to Coast

Guelph, Ont.—The bridge at Guelph from Riverside Park to Wellington Place has been formally opened.

Windsor, Ont.—An offer of Windsor of $155,000 for the Sandwich, Windsor, and Amherstburg railway was refused.

Caron, Alta.—Two more dams for the conservation of water on the west side of the pumping station at Caron, Alta., have been completed.

Toronto, Ont.—The earnings so far for 1914 of the Toronto Street Railway company have amounted to $1,975,304, the earnings for April being $501,435. This means that the company's business is growing at present at a rate of 5.5 per cent. annually.

Niagara Falls, Ont.—A statement of combined gross earnings for the Niagara Falls Power Company and the Canadian Niagara Power Company for the year ending December 31st, 1913, has been given as $2,742,192, an increase of $254,996 over 1912. After deducting 19.70 per cent. of gross for operating expenses, and the various amounts for interest on mortgage bonds, etc., and after adding amounts for other income of the company, the surplus income for 1913 was $1,070,100, compared with $927,857 for 1912.

Medicine Hat, Alta.—The report of the city engineer of Medicine Hat for the month of April showed that the gas system was extended 1,500 feet in the high-pressure mains; the water distribution system, 3,883 feet by means of 6-inch pipe; while domestic sewers were installed amounting to 9,463 lineal feet; and storm sewers, to the extent of 2,837 feet. Also during the month 91,134 square feet of cement sidewalk were laid, making a total of about 3 miles of 6-foot walks; also about 2,250 square feet of street crossings and 432 square feet of lane crossings. The electric light line was extended 9,974 feet, the roadway under the subway in Altawana was widened by placing 37 piles on the edge, the bridge over Ross Creek was refloored, and a number of improvements were made to the various parks of the city.

Victoria, B.C.—Railway construction reports from Victoria show progress on all railroads. Plans have been perfected for commencing grading on the P.G.E. railway between Clinton and Fort George, and the company is also busy arranging for the construction of the road from Fort George to the Peace River country. On the main line of the C.N.P. railway, it is reported that grading will be completed from the Rockies to the coast in June. The building of the Cisco bridge is so far advanced that its completion is promised within a fortnight. Immediately this work is done track-laying will be carried on to Kamloops. As far as this point most of the bridges are in place; and, from Kamloops to the North Thompson, 120 miles of steel is being laid; while the ballasting of the road is being carried on simultaneously with the tracklaying. On the Kettle Valley railway, on the joint section of the Hope Mountain route, more than half of the grading work is complete. With the exception of a 3-mile stretch, grading work is now proceeding on the entire 38-mile section between Hope and Coquahalla Summit, the portion of the Hope Mountain route which is to be used jointly by the V.V. and E. railway and the K.V.R. Also grading is proceeding on the last link of the Kettle Valley railway, which will afford connection with the V.V. and E. at Princeton; and nearly two-thirds of the grading has been completed on the 27-mile section of the latter line between Princeton and Otter Summit. While, north-west of Princeton on the V.V. and E. railway, it is expected that grading will be finished and that tracklaying will commence by the middle of August, and that the section will be ready for traffic late this autumn.

PERSONALS.

ROBT. J. MARSHALL, B.A.Sc., has recently been appointed town engineer of Trenton, Ont

FRANK BARBER, bridge and structural engineer, Toronto, has been retained by the township of Etobicoke as township engineer.

H. B. PEARSON, manager of the Calgary Heat and Light Company, has received the appointment of consulting gas engineer to the city of Calgary.

GEORGE KIDD has been appointed general manager of the British Columbia Electric Railway Company, Vancouver, to succeed R. H. Sperling, resigned.

W. W. PEARSE, formerly of New York, has been chosen by the City of Toronto for the position of city architect, his duties to commence May 18th. Mr. Pearse has spent 20 years in architectural work.

CHAS. G. TOMS, B.A.Sc., has been appointed general manager of the Toms Contracting Company, Limited, Toronto. Mr. Toms is a graduate in civil engineering of the University of Toronto, and took a post-graduate course in

Chas. G. Toms, B.A.Sc.

structural engineering. He has acquired considerable experience in construction work of various kinds, chiefly in concrete and building construction.

J. A. BOYLE, until recently on the construction engineering staff of the C.N.R. at Winnipeg, has been appointed engineer in charge of the construction of the Winnipeg River Railway, a part of the Greater Winnipeg Water District scheme.

GARNET B. HUGHES, son of Hon. Col. Sam. Hughes, has been appointed resident engineer on Vancouver Island for the Department of Public Works. Mr. J. F. McLachlan, who formerly occupied the position, is in charge of the Victoria harbor development.

W. MAXWELL, mine manager of the Lethbridge Collieries, has been appointed government mine inspector for the Crow's Nest Pass district to succeed A. N. Scott, who has accepted the position of manager of the Jasper Park Collieries, west of Edmonton.

LEONARD ANDREWS, M. Inst. C.E., M.I.C.E., managing director of the Canadian British Engineering Company, Limited, has arrived in Winnipeg from England, and will take charge of the Canadian management of his firm. Reginald Porter, who has been the Canadian manager for the past year, has returned to England to resume his previous duties as manager of the London office.

OBITUARY.

The death occurred in Victoria recently of J. M. Sutton, a prominent geologist. Mr. Sutton was a noted authority on the resources of Vancouver Island.

The death occurred last week of A. B. Willmott, B.A., B.Sc., a Toronto consulting mining engineer. Mr. Willmott was a graduate of the University of Toronto, and he also took a post-graduate course at Harvard. Prior to his consulting practice he was manager of mines for the Clergue interests, before the organization of the present Lake Superior Corporation. Previous to that he was associated with academic work, having held a professorship at McMaster University, Toronto, and Antioch College, Ohio. The late Mr. Willmott was in his 48th year.

The death is reported from Brockville, Ont., of John G. Steacy, railway contractor, at the age of 77. Deceased had been associated with many prominent railway construction enterprises in America and abroad. In Canada he built the first 50 miles of the European and North American Railway, from St. John, N.B. He was also associated with the erection of the passenger stations and engine shops of the G.T.R.

COMING MEETINGS.

AMERICAN WATERWORKS ASSOCIATION.—Thirty-fourth Annual Meeting to be held in Philadelphia, Pa., May 11th to 15th, 1914. Secretary, J. M. Diven, 47 State Street, Troy, N.Y.

CANADIAN AND INTERNATIONAL GOOD ROADS CONGRESS.—To be held in Montreal, May 18th to 23rd, 1914. Mr. G. A. McNamee, 909 New Birks Building, Montreal, General Secretary.

INTERNATIONAL CONFERENCE ON CITY PLANNING.—To be held in Toronto, May 25th, 26th and 27th, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

AMERICAN SOCIETY FOR TESTING MATERIALS. —Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

ORDERS OF THE RAILWAY COMMISSIONERS
OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21702—April 29—Authorizing C.N.R. to construct across 23 highways in Province of Saskatchewan.

21703—April 29—Authorizing C.P.R. to reconstruct 2 bridges in Province of Manitoba, namely,—No. 7.6, Emerson Sub. Div., Man. Div., and No. 8.4, Winnipeg Branch Sub. Div., Man. Div.

21704—April 29—Authorizing C.P.R. to reconstruct bridge No. 11.9 on Brandon Sub. Div., Man. Div., Manitoba.

21705—April 28—Authorizing C.P.R. to construct tracks of spur to ballast pit across highway between Secs. 22 and 27-18-17, W. 3 M., Sask., mileage 23.79 on Swift Current North-westerly Branch Line.

21706—April 21—Approving and authorizing, temporarily, clearances as shown on plan under File No. 23749, subject to condition that C.P.R. undertake to keep employees off sides of cars while shunting on tracks Nos. 17, 18, and 19, in West Toronto Yard, and pending rearrangement by Ry. Co., of switching lead to provide standard 13-foot clearances between centres of all tracks.

21707—April 25—Authorizing C.N.R. to construct, subject to terms of agreement, spur to gravel deposit, N.W. ¼ Sec 8-15-1, W.P.M., for Lake Winnipeg Shipping Co., and cross certain highways.

21708—April 29—Authorizing C.P.R. to construct spur for Canada Cement Co., Limited, Montreal, Que., from point in easterly limit of right of way of main line, mileage 7.1, La Riviere Subdivision, Man. Div., across lands of Huebach and Co.; across road allowance and Lots 1, 2 and 3, Parcel B, parish of St. Charles, Man.

21709—April 29—Authorizing C.P.R. to construct spur for Calgary Paint and Glass Co., Limited, Calgary, Alta., subject to and upon certain conditions.

21710—April 29—Approving By-Law No. 15, authorizing G.T.P. Ry., to appoint G. T. Bell, Pass. Traffic Mgr., W. P. Hinton, Assist. Pass. Traffic Mgr., and W. E. Duperow, Assist. General Pass. Agt., to prepare and issue, from time to time, tariffs of tolls to be charged for passenger traffic upon railway owned or operated by Co., or any portion thereof, and to specify the persons to whom, place where and manner in which such tolls shall be paid; and rescinding Order No. 8288, dated October 8th, 1909.

21711—April 28—Directing G.T.R. to install gates, operated by day and night watchmen, at crossing by its tracks of Eighteenth Ave., city of Lachine, and apportioning cost of installing, maintaining and operating said gates; also rescinding Order No. 9616, dated February 7th, 1910, directing installation of an electric bell at said crossing.

21712—April 29—Authorizing C.N.O.R. to construct across Weston Plank Road, city of Toronto, by means of structure carrying highway over railway.

21713—April 29—Authorizing Pointe aux Trembles Terminal Ry., to construct across Montreal Terminal Ry. in parish of Pointe aux Trembles, Que., subject to certain conditions.

21714—April 29—Authorizing C.P.R. to construct, at grade, an additional track (double track) of main line, Farnham Subdivision across Champlain St., town of St. Johns, Que., mileage 19.9, temporarily, pending hearing of matter at sittings of Board to be held in Montreal, May 15th, 1914.

21715—April 30—Approving location C.P.R. platform and shelter, at mileage 9.20 on Bobcaygeon Subdivision, Ont. Division, in Lot 20, Con. 9, Tp. Cartwright, Co. Durham, Ontario.

21716—April 30—Dismissing complaint of R. L. Rice of Vancouver, B.C., against charge made by C.P.R. for 2 seats in a sleeping car for daylight journey from Sicamous, B.C., to Vancouver.

21717—April 30—Authorizing C.N.R. to operate trains, temporarily, for construction purposes only, for period of 90 days from date of this Order, pending installation of interlocking plant, over crossing of C.P.R., Lot 101, parish of St. Paul, Man.: provided trains be flagged over crossing by watchmen, appointed by C.P.R., at expense of C.N.R. and rescinding Order No. 21617, dated April 9, 1914.

21718—April 30—Approving By-Law of G.T.R. appointing certain men to prepare and issue tariffs of tolls for passenger traffic on railway owned or operated by Co., or any portion thereof; and rescinding Order No. 13449, dated April 18th, 1911.

21719—April 28—Relieving G.T.R. from providing further protection at crossing of highway known as Danforth Road, east of Scarboro Junction, Ontario.

21720—April 30—Authorizing G.T.R., to construct siding into premises of William R. Smith, on part Lot 7, Con. 1, from Bay, in Tp. York, now in city of Toronto.

21721—May 1—Amending Order No. 4353, dated February 3rd, 1908, by striking out last paragraph in operative part of Order and substituting following:—"That Pacific Co. repay or refund to Campbell, Wilson and Horne, Limited, by way of rebate, ½ tolls charged by Pacific Co., in respect of carriage of traffic for said Campbell, Wilson and Horne, Limited, Geo. R. Marnoch, and the Western Supply and Equipment Co., over said branch line or spur."

21722—April 27—Authorizing C.P.R. to take certain tract of land in parish of St. Martin, Co. Laval, Que., for purpose of enlarging station yard at Laval Rapids.

21723—May 1—Approving C.P.R. plan "A," showing proposed rearrangement of interlocking plant at crossing of Q.M. and S. at Iberville Jct., Quebec.

21724—April 28—Approving C.P.R. plan dated Brandon, April, 1914, and showing layout of crossing bell at First Ave., Oak Lake, Man.; and relieving Company from speed limitation of 10 miles an hour in operation of trains over said crossing.

21725—April 29—Authorizing C.L.O. and W. Ry. (C.P.R.) to construct across unopened road allowance between Lots 4 and 5, mileage 88.62, Con. 1, Tp. Murray, East Riding, Co. Northumberland, Ontario.

21726—April 22—Authorizing G.T.R. to construct siding into premises of S. W. Marchmont, on Lot 47, Tp. Niagara, Co. Lincoln, Ont., near St. Davids.

21727—April 27—Authorizing Cedars Rapids Manufacturing and Power Company of Montreal to take additional width for right of way for its transmission line across Lot 122, parish of St. Ignace du Coteau du Lac, property of Rev. Chanoine Dauth.

21728—April 29—Authorizing Marcil Trust Co., Limited, to relocate farm crossing on Official Lot 61, parish of Pointe Claire, west of Strathmore Station, Que., to point about 75 ft. easterly from present location, work to be done under supervision of Engineer of G.T.R. Co.

21729—April 22—Authorizing C.N.R. to cross abandoned right-of-way of C.P.R. in town of East Selkirk, Man.; and reserving question of seniority and protection until such time as C.P.R. desire to lay tracks in right-of-way at this point.

21730—April 29—Authorizing C.N.O.R. to construct across Silverthorne Ave., Toronto, by means of structure carrying highway over railway.

21731—May 1—Authorizing G.T.P. Ry. to construct ladder tracks across Kinistino Ave., Edmonton, Alta.; and approving station for freight with accommodation and facilities in connection therewith, subject to certain conditions.

21732—May 1—Authorizing Cedars Rapids Manufacturing and Power Co., Montreal, to take additional width of 25 ft for right of way for transmission line, across certain lots, parish of St. Ignace du Coteau du Lac, Co. Soulanges, Que.

21733—May [illegible]—Amending Order No. 21480, March 13th, 1914, by striking out words and figures, "at mileage 1.11 (spur mileage), town of Trenton, Ont., as shown on plan, profile and book of reference combined," in lines 5, 6 and 7, paragraph 1 of operative part of Order, and substituting words and figures, "at mileage 1.43, town of Trenton, as shown in yellow down to point near intersection of Ann and Ontario St., and in red from that point to point near Dundas St., at mileage 1.43 on plan, profile and book of reference combined."

21734—May 2—Directing that G.N.W. Tel. Co. remove its wires and poles from Kent and certain other streets in town of Lindsay, Ont., subject to certain conditions. That G.N.W. Tel Co., pay expense of making necessary connections as set out in clauses (a), (b) and (c) herein; cost of remainder of work be paid $150 by G.N.W. Tel Co., balance by Applicant (town of Lindsay).

21735—May 1—Directing that C.N.R. erect fences along right of way (Ottawa-Capreol Line) through Twps. Field, Crerar, Badgerow and Gibbons, Dist. Sudbury, Ont., within 60 days from date of this Order.

21736—May 1—Authorizing C P.R. to construct spur into premises of National Cash Register Co., situate in Tp. Lot 27, Con. 2, from the Bay, in Tp. York, Co. York, Ontario, subject to certain conditions.

21737—May 2—Authorizing G.T.P. Branch Lines Co. to carry traffic over portion of Young to Prince Albert Branch Line, Sask., between mileage 67 (Wakaw) and 87: Provided speed of trains operated over said portion be limited to rate not exceeding 15 miles an hour.

21738—May 2—Authorizing C.P.R. to reconstruct Bridge No. 5.3 on Walkerton Subdivision, Ont. Division, near Priceville Station, Ontario.

21739—May 2—Authorizing C.N.R. and C.P.R. to operate trains over crossing in Sec. 35-24-27, W. 4 M., Alta., without their being brought to a stop.

21740—May 4—Amending Order 21481, March 13th, 1914, by striking out figures and word "0.47 and 0.74" in 5th line of operative part of Order and substituting therefor figures and word "0.55 and 1.05"; and by striking out words and figures "October 2, 1913" in 6th line of operative part of Order and substituting words and figures "November 25, 1913."

21741—May 2—Approving Lake Erie and Northern Ry. Co.'s plan of overhead bridge at crossing of highway between Cons. 2 and 3, Tp. Brantford, Ont., mileage 16.92.

21742—May 2—Authorizing T.H. and B. and Hamilton St. Ry. Co. to operate their trains and cars over crossing on Barton St., City of Hamilton, without being brought to a stop.

21743—April 20—Approving Bell Telephone Co. agreement entered in with Municipal Corporation of Tp. of Brighton, dated March 31st, 1914, for interchange of telephone messages or service passing to or from their respective telephone systems and lines.

21744—May 2—Authorizing G.T.P. Ry. to construct main line across and divert highway in Lot 935, Cariboo Dist., B.C., mileage 232.3 Yellowhead Pass West.

21745—May 2—Directing that classification of maple butter be made the same as classification of peanut butter, the change to be included in Supplement No. 3 to Canadian Freight Classification No. 16.

21746—May 4—Disallowing Supplement No. 146 to G.T.R. Special Tariff, C.R.C. No. E-2552, increasing rate on clay, in carloads, from Waterdown to Swansea and Mimico, Ont., from 1½ cts. per 100 lbs. to 2 cts. per 100 lbs., and the rate of 1½ cts. per 100 lbs. is restored.

21747—May 4—Authorizing Cedars Rapids Manufacturing and Power Co. of Montreal, to take additional land for right of way for its transmission line, across certain lots in parish of St. Joseph de Soulanges, Co. Soulanges, Que., property of Adolphe Tessier, Maurice Tessier and Maurice Tessier and Adolphe Tessier.

21748—May 2—Authorizing Rural Municipality of Usborne No. 310, Sask., to construct crossing over C.P.R. Pheasant Hills Branch at West Boundary of S.E. ¼ Sec. 34-33-23, W. 2 M., Sask.; and rescinding Order No. 21452, dated March 9, 1914.

21765—May 6—Approving Supplement No. 4 to Express Classification for Canada No. 3, containing changes with respect to carriage of moving picture films, organs, pianos [illegible] player [illegible].

21766—May 6—Authorizing T.H. and B. Ry. to divert highway between Lots 21 and 22, Con. 5, Tp. Gainsboro, Co. Lincoln, Ont.; also authorizing Ry. Co. to acquire from owner thereof a 66-ft. parcel of land connecting said highway between Lots 21 and 22, Con. 5, Tp. Gainsboro, with highway between Cons. 5 and 6, and to convey to Tp. Gainsboro said 66-ft. parcel, for highway purposes, in lieu of parcel colored yellow on plan.

General Order, No. 124—April 30—Approving regulations to govern operation by railway companies within legislative authority of Parliament of Canada, of draw, or swing, or bascule bridges over navigable waters.

21767—May 5—Authorizing T.H. and B. Ry. to install automatic block signals on its railway between Welland and Hamilton, Ont.; and approving plans of said signals. And rescinding Orders Nos. 14066 and 15974, dated respectively June 24th, 1911, and February 14th, 1912.

21768—May 6—Authorizing C.P.R. to construct spur for Pilkington Brothers, Limited, in city of Calgary, Alta.

21769—May 6—Authorizing C.P.R. to open for traffic portion of double track from mileage 109.4 to 110.5 on Swift Current Subdivision.

21770—May 6—Authorizing C.P.R. to take certain lands in city of Peterboro, Ont., for purpose of providing team road to its freight yard in said city.

21771—May 6—Authorizing C.P.R. to construct extension to siding for William Neilson, Limited, Toronto, Ont., across Zorra St. and along and across Durham St., village of Beachville.

21772—May 7—Authorizing C.P.R. to open for traffic portions of Bergen Northeasterly Line, double track, from mileage 0 to 9.92; Emerson Subdivision, second track, mileage 0 to 2.03; and Lac du Bonnet Subdivision from Whittier, mileage 65.1 to Murdock, mileage 62.2—all in Province of Manitoba.

21773—May 6—Authorizing C.P.R. to construct spur into premises of F. Sask and Co., Limited, and The Constructors, Limited, in city of Regina, Sask.

21774—May 7—Approving plan No. X-2-317/6, dated April 7th, 1914, showing interlocking plant proposed to be installed at crossing of Owen Sound Section of C.P.R. by G.T.R. at Weston Road, town of Toronto Junction, Ontario.

21775—May 7—Authorizing C.P.R. to construct spur for Brunelle and Besner, Vaudreuil, Que., from point on southerly limit of right of way of C.P.R. at mileage 19.47, Smith's Falls Subdivision, Lot Cadastral No. 458, parish of St. Michel de Vaudreuil, Co. Vaudreuil, Que.

21776—May 7—Authorizing C.P.R. to construct spur for Canadian Sewer Pipe and Clay Product Co., Limited, Hamilton, Ont., across lands belonging to Tp. West Flamboro in shape of an unopened road allowance between Cons. 1 and 2, Tp. West Flamboro, Co. Wentworth, Ont., at mileage 1.0 on Hamilton and Goderich Subdivision.

21777—May 2—Approving terms of contract entered between Byron Telephone Co., Limited and Bell Telephone Co. of Canada.

COL. RUTTAN'S RETIREMENT.

It has been announced that Col. H. N. Ruttan, for many years city engineer of Winnipeg, will be relieved of his duties on June 1st next. Col. Ruttan's resignation has not been entirely unexpected. In fact, it was intimated last year that he contemplated resigning at an early date. The untimely death of R. D. Willson, assistant city engineer, delayed the matter, however, and he was induced to continue in office until the disorganization which the fatality had produced would be remedied.

Col. Ruttan is not completely severing his connection with the city. It is understood that he will be retained as consulting engineer at a salary approximating that which he has been receiving as city engineer.

Operations are now proceeding at the Cape Town docks, South Africa, for the erection of 3 huge steel tanks for the storage of oil. The tanks will each contain 4,000 tons of oil, and the total capacity of the three will be 2,688,000 gallons of liquid fuel. The oil will be delivered to ships by means of 10-inch steel piping laid beneath the quay surface, and will also be available for manufacturing and other purposes.

NEW INCORPORATIONS.

Vancouver, B.C.—McIntyre Lumber Co., Limited, $10,000.

Frank, Alta.—Franco-Canadian Collieries, Limited, $1,300,000.

Drumheller, Alta.—Alberta Block Coal Co., Limited, $300,000.

Victoria, B.C.—V. I. Contractors Supply Company, Limited, $10,000.

Maryfield, Sask.—Village of Maryfield Telephone Co., Limited, $2,500.

Nelson, B.C.—Kootenay Granite and Monumental Company, Limited, $50,000.

Grand Forks, B.C.—The Grand Forks Concrete Company, Limited, $10,000.

Medicine Hat, Alta.—Frank H. Gheen, Jr., Gas and Oil Co., Limited, $200,000.

Fort George, B.C.—Northern Interior Light and Power Company, Limited, $50,000.

Hamilton, Ont.—Pay Ore Mines, Limited, $500,000. J. M. Fletcher, B. O. Johnson, E. Farr.

Ottawa, Ont.—Coal Trestle Co., Limited, $300,000. L. A. Ray, G. P. Murphy, R. T. Holcomb.

Calgary, Alta.—Summit Engineering Co., Limited, $50,000. J. H. Goodwin, Limited, $300,000.

Milton, Ont.—Bowlby Sand, Lime, Brick Co., Limited, $100,000. R. Bowlby, R. Boyd, W. I. Dick.

Montreal, Que.—Federal Paper Co., Limited, $100,000. J. J. Meagher, H. N. Chauvin, P. W. Peacock.

Gowganda, Ont.—Gowganda Power Co., Limited, $100,000. J. G. Shaw, J. Montgomery, H. P. Edge.

Seven Islands, Que.—Wynros Navigation Co., Limited, $99,000. G. M. Ross, A. H. Ross, C. E. Ross.

Lancaster, Ont.—The Lancaster Water Works, Limited, $20,000. J. A. Bourbeau, A. Powell, T. Aubry.

Canfield, Ont.—The Azoff Natural Gas Co., Limited, $40,000. H. R. Laird, W. Thompson, A. Moodie.

Valleyfield, Que.—The New Salaberry Quarry Co., Limited, $20,000. J. Dubord, J. Lefebvre, B. Rheaume.

Montreal, Que.—Bernard Construction Co., Limited, $20,000. L. A. Bernard, L. J. Bernard, J. Turcotte.

Windsor, Ont.—General Vending Machines, Limited, $25,000. J. P. Jacques, A. J. Janisse, A. L. Lafferty.

Guelph, Ont.—Munder Tungsten Lamp Company, Limited, $50,000. J. S. Wheeler, J. E. Carter, J. Davidson.

Welland, Ont.—The Corbett Contracting Company, Limited, $100,000. J. H. Corbett, E. Corbett, J. H. Corbett.

Carey, Man.—The Carey Elevator Co., Limited, $20,000. A. Prefontaine, E. Hebert, C. Dandenault, J. F. Lambert.

Parry Sound, Ont.—William Beatty Lands and Timber, Limited, $100,000. E. Beatty, W. J. Beatty, F. I. M. Beatty.

Walkerville, Ont.—Thomas Reinforced Concrete Co., Limited, $50,000. A. Thomas, G. B. Wadham, A. A. Stibbard.

Winnipeg, Man.—The Murray Carbon Remover Co., Limited, $20,000. J. H. G. Russell, A. E. Emby, H. L. Willson.

Saint Leonards, N.B.—The Benn Train Signal System Co., Limited, $199,900. W. E. Benn, F. E. Rivard, L. J. Violette.

Thessalon, Ont.—The McEachern Tie and Timber Co., Limited, $40,000. E. S. Perryman, J. A. McEachern, W. McGuire.

Alvinston, Ont.—The Alvinston Brick and Tile Company, Limited, $40,000. R. F. Rilett, J. Holme, R. H. Brownlee.

St. Boniface, Man.—St. Boniface Garage and Motor Company, Limited, $75,000. F. T. Taylor, E. A. Conde, J. A. Ptolemy.

Hamilton, Ont.—The Skootamatta Power and Development Co,, Limited, $300,000. H. D. Petrie, S. L. Heaton, M. E. Smith.

St. John, N.B.—The Saint John Automobile Trade Association, Limited, $2,000. J. A. Pugsley, F. W. Coombs, G. H. Lounsbury.

Hull, Que.—The Lower Ottawa Forest Protective Association, Limited, $10,000. Hon. W. C. Edwards, W. C. Hughson, G. H. Millen.

Vancouver, B.C.—Burrard Engineering Company, Limited, $100,000. Automatic Electrical Heat Controller Company, Limited, $200,000.

Hamilton, Ont.—Refractory Ore Converters, Limited, $150,000. J. W. Lamoreaux, J. J. Markham, F. Grew. Canadian Engineering and Contracting Co., Limited, $100,000. J. J. Mackay, F. W. Paulin, F. A. Magee.

Edmonton, Alta.—Alberta Construction Co., Limited, $10,000. The Jamieson Construction Co., Limited, $25,000. The Cast Stone Construction Co., Limited, $25,000. Lake Athabaska Mining Co., Limited, $1,000,000.

Vancouver, B.C.—Elliott Rail Company, Limited, $20,000. Montgossam Ground Hog Coal Company, Limited, $100,000. Railway Supplies, Limited, $100,000. The Hazelton Coal and Development Company, Limited, $250,000.

Montreal, Que.—Canada Coke Corporation, Limited, $75,000. F. S. Maclennan, C. C. L. deKalisz Stephens, J. W. Weldon. Timber Properties and Securities, Limited, $50,000. W. R. L. Shanks, F. G. Bush, G. R. Drennan.

Vancouver, B.C.—Selkirk Power Co., Limited, $35,000. Huntting Merritt Lumber Co., Limited, $100,000. Seymour Creek Placer Mining Co., Limited, $250,000. Antler Creek Gold Mines, Limited, $80,000. Mitchell Lumber Co., Limited, $25,000.

Hamilton, Ont.—Ore Mountain Mines, Limited, $1,000,000. D. A. Fletcher, J. A. Barr, G. Hogarth. The Toronto and Hamilton Electric Company, Limited, $200,000. R. Lynch, H. E. Job, L. F. Stephens. Wentworth Motors, Limited, $40,000. D. B. Wood, C. W. Heming, A. T. Heming.

Winnipeg, Man.—The Anglo-Alberta Coal Co., Limited, $100,000. E. C. Complin, R. G. Holmes, N. McKay. Canadian Sarco Engineering Co., Limited, $20,000. A. R. Roberts, G. H. Ross, D. Nicholson. Terminal Cities Construction Co., Limited, $160,000. C. S. Napier, A. H. Hepworth, S. Lawler.

Toronto, Ont.—Maple Leaf Lumber Co., Limited, $40,000. E. F. McDonald, J. M. Adam, A. C. Rutherford. Ontario Northern Construction Co., Limited, $300,000. M. Young, J. A. McEvoy, C. Carrick. Northeast Kirkland Mining and Development Co., Limited, $750,000. A. Poyntz, H. E. Ridout, G. A. Jarvis.

Toronto, Ont.—Polson Dry Dock and Shipbuilding Co., Limited, $2,000,000. J. Stewart, W. Gilchrist, G. Hancock. Automatic Chemical Sprinkler Co., Limited, $100,000. G. A. Robinson, A. G. Boylan, G. F. Clare. Pneumatic Wheel Co., Limited, $200,000. C. F. Ritchie, J. H. Oldham, W. J. Beaton. The Weatherhead Paper Co., Limited, $40,000. F. M. Weatherhead, F. Weatherhead, W. A. Newton.

Toronto, Ont.—Canadian Turbine Co., Limited, $50,000. P. H. F. Spies, W. North, E. Watt. The Cataract Junction Sand and Gravel Company, Limited, $50,000. A. V. Trimble, E. F. Latimer, W. G. Hewson. Rotary Amalgamators, Limited, $40,000. M. Macdonald, G. Adams, E. Smily. Laurabel Silver Mines, Limited, $1,000,000. J. F. MacGregor, J. S. Duggan, W. R. Anderson. Toronto Sand and Gravel Co., Limited, $50,000. E. Duggan, W. A. Bew, G. B. Coyne.

Toronto, Ont.—Ontario Construction and Investments, Limited, $40,000. J. E. Day, J. M. Adam, S. C. Arrell. Lake Shore Sand and Gravel Company, Limited, $250,000. A. Adamson, Miller, G. T. Denison, R. S. Smith. The Antonio Silver Mines, Limited, $1,500,000. C. G. Ogden, B. Bourdon, L. Beauregard. Motor-Dromes, Limited, $125,000. G. R. Sproat, F. Metcalfe McDowell, J. T. White. Whyte Foundry Company, Limited, $40,000. J. A. Kent, J. M. Langstaff, C. W. Thompson.

Winnipeg, Man.—The General Building and Contracting Company of Canada, Limited, $60,000. L. E. Hird, F. A. Gilman, T. Pickles. The MacDonald Brothers Sheet Metal and Roofing Company, Limited, $5,000. J. D. MacDonald, G. MacDonald, E. MacDonald. The Manitoba Construction Company, Limited, $60,000. C. Buffet, P. Grant, G. Cottenier. Manitoba Gravel and Sand Company, Limited, $100,000. E. A. Conde, J. A. Ptolemy, A. B. Rutherford. Automatic Telephone Manufacturing Company, of Canada, Limited, $1,000,000. H. Phillipps, C. S. A. Rogers, H. St. Clair Scarth.

Toronto, Ont.—Watson Cycle-Car Company, Limited, $100,000. S. A. Watson, E. Knox, C. Inrig. The Inland Construction Company, Limited, $200,000. M. K. Lennox,

B. F. Fisher, M. E. Dancey. Universal Tool Steel Company, Limited, $10,000,000. G. Ruel, R. H. M. Temple, A. J. Reid. Electric Furnace Products Company, Limited, $5,000,000. H. E. Wallace, R. Pike, J. A. Christilaw. Dominion Engineering and Machinery Company, Limited, $2,000,000. G. M. Kelley, J. D. Falconbridge, A. C. McFarlane. Principello Steamships, Limited, $150,000. G. Ruel, S. C. Snively, A. J. Reid. Canadian Fleischer Gas Company, Limited, $40,000. R. B. Bruce, J. L. Counsell, L. Archibald. Canadian Expansion Bolt Company, Limited, $40,000. E. W. Wright, G. P. Robinson, L. R. Zifferer. Favary Tire Company, Limited, $500,000. F. Kitching, D. H. Arnott, R. J. Young. Demees Electroplating and Manufacturing Company, Limited, $40,000. F. Demees, W. Caspar, J. H. Barrett. Porcupine Pet Gold Mine, Limited, $1,000,000. G. H. Sedgewick, J. Aitchison, D. McArthur. Porcupine Porphyry Hill Gold Mines, Limited, $1,000,000. H. Sedgewick, J. Aitchison, D. McArthur.

PATENTS ISSUED.

The following are among the Canadian patents recently issued through the agency of Messrs. Ridout and Maybee, 59 Yonge Street, Toronto, from whom further particulars may be obtained:—Toofron Boberg, catalytic hydrogenation of organic substances; George and Leonard Fuller, electrical accumulators or secondary storage batteries; Charles Oliver and Wm. D. Pell, electrodes for flame arc lamps; Charles Caille, processes for superheating steam taken from generators; David Evans, time indicating dials; Herman P. E. Miller, valve mechanism for internal combustion and other engines; George A. Quin, pneumatic tires; Marcus Ruthenberg, electrodes for electric furnaces; Walter W. Smith, building blocks; Henry Watkinson, plastic cement.

Below will be found the list of Canadian patents recently furnished by Messrs. Fetherstonhaugh and Co., patent barristers, solicitors, etc., Toronto, Hamilton, Montreal, Ottawa, Winnipeg, Vancouver and Washington, D.C., from whom all information may be readily obtained:—

W. T. B. McDonald means for stopping trains; P. Ackerman, selective cut outs for alternating current circuits; W. Edwards, safety lock shoes for rails; J. F. Hughes, flushing devices for hydraulic elevators; B. E. Larsen, spring supporters for single blocks; J. A. McLarty, processes of treating organic and inorganic materials; A. E. Quinn, saw combination tools.

TRADE INQUIRIES.

Since the publication of the last Weekly Report there have been received the following inquiries relating to Canadian trade. The names of the firms making these inquiries, with their addresses, can be obtained only by those especially interested in the respective commodities upon application to: "The Inquiries Branch, The Department of Trade and Commerce, Ottawa," or The Secretary of the Canadian Manufacturers' Association. Toronto, or The Secretary of the Board of Trade at London, Toronto, Hamilton, Kingston, Brandon, Halifax, Montreal, St. John, Sherbrooke, Vancouver, Victoria, Winnipeg, Calgary, Saskatoon, and Chambre de Commerce du Montreal:—

A South American firm inquires for rubber hose. Four South American firms inquire for roofing. A South American firm inquires for aerial cables. South American firms inquire for pumps. A firm in Colombia, South America, inquires for small corundum wheels. A firm in Colombia, South America, inquires for mine supplies. A firm in Colombia, South America, inquires for rails. A firm in Colombia, South America, inquires for steel sleepers. A firm in Colombia, South America, is prepared to handle railway material and rolling stock. Two South American firms inquire for cement. A Colombia, South America, firm inquires for steel bridges. A South American firm inquires for the above. A Japanese company who manufacture asbestos tiles wishes to get into touch with manufacturers and exporters of asbestos fibre in Canada. A British firm in Yokohama wishes to get in touch with reliable exporters of Canadian pulp for paper-making. A London firm asks to be placed in communication with Canadian manufacturers of pemmican. A London firm wishes for the addresses of Canadian firms who can contract to supply birch or maple veneer panelling in large quantities. A prominent importing firm in Hamburg desires to hear from a first-class Canadian house producing or dealing in the above, seeking a representative for Germany and the Continent. Three firms in South America inquire for asbestos roofing. An Englishman carrying on a general commission business in Medellin, Colombia, would be glad to have samples of calcium carbide, both large and small; the former to be 1¼ inches by ⅜ inch, and the latter ¼ inch by ⅛ inch. Quotations c.i.f. Puerto Colombia.

SOME GOVERNMENT CONTRACTS AWARDED RECENTLY.

The following contracts were awarded by the different departments of the Ottawa Government in March, 1914, and are published by the Labor Gazette, together with names and addresses of contractors, and amount of contracts:—Wharf, Shediac Island, N.B. Warren Taylor, Salisbury, N.B., $6,432; breakwater, Caldwell's Cove, N.S. Whidden and Landry, Antigonish, N.S., $6,900; dredging, Sand Heads (mouth of Fraser River), B.C. Navigation Dredging Co., Limited, Vancouver, B.C. Class "B," $0.23½ per cubic yard; renewal of south pier, Burlington Channel, Ont. MacKay, Paulin Construction Co., Limited, Hamilton, Ont.; dredging, Dalhousie, N.B. The Northern Dredging and Construction Co., Limited, Vancouver, B.C. Class "A," $5; Class "B," $0.30 per cubic yard; dredging, Charlottetown, P.E.I. V. T. Bartram, Toronto, Ont. Class "B," $0.28 per cubic yard; wharf, Ste. Anne des Monts, P.Q. John Burns, Ottawa, Ont., $112,000; breakwater, Blanford, N.S. C. A. Strum and Son, Mahone Bay, N.S., $13,721; wharf, Heustis Landing, N.B. Melvin Jones, Cambridge, N.B., $6,275; railway dry dock, Selkirk, Man. The Crandall Engineering Co., Portland, Me., U.S.A., $72,000; roaster building and extension to fuel shed, fuel testing plant, Ottawa, Ont. Taylor and Lackey, Ottawa, Ont., $6,979; wharfs, Victoria Harbor, B.C. Grant, Smith and Co., and McDonnell, Limited, Vancouver, B.C.; wharf, Fitzroy Harbor, Ont. Thos. and John Moran, Arnprior, Ont.; wharf, Thurso, P.Q. Alf. Belanger and Co., Papineauville, P.Q.; wharf, Ainsworth, B.C. J. Dancy and Son, Nelson, B.C., $9,242; pile wharf and approaches, Gananoque, Ont. W. J. Sims, A. Robertson and R. A. Bingham, Ottawa, Ont.; public building, Milverton, Ont. Walter F. Martin, Gananoque, Ont., $24,642; public building, Carman, Man. Snyder Brothers, Portage la Prairie, Man., $29,200; one passenger and three freight elevators in examining warehouse, Calgary, Alta. The Turnbull Elevator Manufacturing Co., Toronto, Ont., $15,950; passenger elevator and motor generator in post office, Moose Jaw, Sask. Otis Fensom Elevator Co., Limited, Toronto, Ont., $5,200. Roofing of St. Gabriel shed No. 1, on the Lachine Canal, Ottawa Street, Montreal; concrete dam across the Rideau River, on the Rideau Canal, Merrickville, Ont. John O'Toose, Ottawa, Ont.; manufactures and erection of a rolling deck steel bridge over the entrance to Basin No. 1, Soulanges Canal, at Cascades Point, P.Q. The Phœnix Bridge and Iron Works, Limited, Montreal, P.Q., $975,000; installation of a telephone train despatching line between Moncton, N.B. and Truro, N.S., on the Intercolonial Railway. The Northern Electric and Manufacturing Co., Limited, $13,974.57; construction and erection of the steel superstructure of five bridges on the Dartmouth to Dean's Branch of the Intercolonial Railway. Dominion Bridge Co., Limited, Montreal, P.Q., $19,748.

IRRIGATION IN AUSTRALIA.

New South Wales has under construction a storage reservoir with a capacity of 33,000,000,000 cu. ft., which constitutes the largest storage scheme in Australia. It is situated on the Murrumbidgee some 300 miles west of Sydney.

The Tri-State Water and Light Association held its fourth annual convention at Atlanta, Ga., having a 2 days' session, commencing April 16, with an attendance of members from Georgia, North and South Carolina. The association discussed such subjects as the purification and treatment of water, the conservation and protection of water supplies and various problems relating to municipal lighting

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

OSHAWA SUB-STATION OF THE ELECTRIC POWER CO.

DESCRIPTION OF THE AUXILIARY POWER PLANT AND SUB-STATION AT OSHAWA, ONT., AND OF THE LARGEST DIESEL OIL ENGINE IN OPERATION IN CANADA.

THE Electric Power Company, Limited, have recently erected and equipped a sub-station and power house in the town of Oshawa, Ont. The power house, to which special reference is made in this article, will be used as a stand-by, to supply light and power to the towns of Oshawa and Whitby in case of trouble or breakdown on the company's high tension transmission lines. The company have an extensive light and power system in the Trent valley, with generating stations at Trenton, Frankfort, Campbellford, Healey Falls, Peterborough and Fenelon Falls. The new Oshawa plant is connected thereto so that it may be immediately thrown into commission to feed back upon the line in case of a shut-down at any point west of Port Hope.

Layout of Building.—The power house and sub-station are housed in an L-shaped building, shown in Fig. 1. The power house is approximately 50 x 52 ft., and the sub-station, containing two rooms, for the switchboards and transformers respectively, measures about 62 x 36 ft. The entire building is of fireproof construction, being of steel framework encased in brick with concrete foundation. It is equipped with steel sash, reinforced concrete floors, and a concrete roof supported by trusses and I-beams. At present the north end of the building is temporarily enclosed, pending an 80-foot future extension.

Power House Arrangement.—A portion of the power house section of the building is shown in Fig. 2. It consists of one large room, to the lighting of which special attention has evidently been paid, steel sash windows extending well towards the ceiling. The room contains one Diesel engine unit of 615 b.h.p., to be described later. The foundations are already in place for a second engine, and provision has been made in the layout for four additional engines, making a complete stand-by station of six units within the building, with all the usual auxiliaries, the yard being laid out for three cooling towers, each tower serving two engines, and six oil tanks of 10,000 gallons each, only one of which is as yet in place.

Fig. 1.—Exterior View of Power House and Sub-station.

Rapid transfer of the oil from tank cars on the power house siding to the main tanks is obtained by a motor-driven centrifugal pump in a small adjacent pump-house. From the main tanks the oil is pumped by a motor-driven rotary pump to two auxiliary tanks, each of 400 gals.

capacity, carried by the roof trusses. From this point the oil is delivered automatically as required to the filter tank adjacent to the engine.

The engine room is equipped with an 8½-ton hand-power crane with a 25-foot lift. The crane has a two-speed hoist and a hand-operated brake, and was supplied by the Whiting Foundry Equipment Co., Harvey, Ill.

The Diesel Engine.—The engine is the largest Diesel engine in Canada, and, as far as we have been able to ascertain, on this continent. It is a 4-cylinder, 615-h.p., Willans-Diesel, designed and constructed by Willans and Robinson, Limited, Rugby, England. It is of the inverted vertical open forced-lubrication type. Its cylinders are single-acting and work on 4-stroke cycle. The normal speed is 180 r.p.m. The engine is guaranteed for a 10% overload for two hours—it was, however, operated for four hours at this overload during the test, carrying its load with ease, and without extra attention.

Some features of the design of this type of engine deserve special mention. The crank-chamber is of the "A" frame type, favored by the makers owing to its adaptability to ready alterations to component parts, everything from the cylinder crown downwards, with the exception of the bed-plate and crank shaft, being identical for engines of from one to four cylinders. It is claimed also that this form permits of easy removal of cylinder, etc.

The cylinder wall is in the form of a tube, which is pressed into the single casting that forms the frame and the water-jacket casing.

The cylinder liner and head are held in position in the framework by studs screwed into the flange formed at the top of the water-jacket casing. These studs, passing through the cylinder head in which is formed the male portion of the tongue and grooved joint, serve also to hold the liner against a shoulder in the flange. Otherwise the liner is free to slide in the two bearings at the centre and base of the jacket casing.

The valves are opened and closed by cams and springs respectively. The cams are keyed on a horizontal shaft driven by an upright shaft and screw gearing from the compressor end of the crank shaft. The exhaust valve levers are in two parts to facilitate the examination of the valves, and the cylinder covers are so designed that the fuel valves are accessible without removing the levers which open them. None of the valves are water-cooled, but the jacket of the exhaust valve casings extend around the valve spindle guides. It is noticeable that the usual order of adjustment on the valve tappets is reversed in this engine. When the valve is on its seating, clearance is to be found between the cam and cam roller, rather than between the valve and operating arm. This is due to the design of the air and exhaust valve levers.

The cam shaft is supported by brackets bolted to the cylinder jacket casting. The bearings are ring-lubricated.

The piston is made of two castings, bolted together. The parts exposed to high temperatures are oil-cooled, by the forced-lubrication system, which is also employed for the crank shaft and connecting rod bearings. A gear pump of drum type, driven by a screw gearing, is located in the base of the engine. Oil is conducted from the main bearings through the drilled crank shaft, and from the crank end to the piston end of the connecting rod by a small pipe and thence to visible discharge cocks. Copious flooding of the cooling chamber in each piston is maintained through trombone tubes by the same oil pump. To prevent destruction of the lubricating qualities of the oil by excessive heating, the system is provided with two tubular coolers arranged in series.

There is one fuel pump, which discharges into a distribution box fitted with four outlet valves, one for each cylinder, adjustable by hand. The governor, which is mounted on the upright shaft between the crank and cam

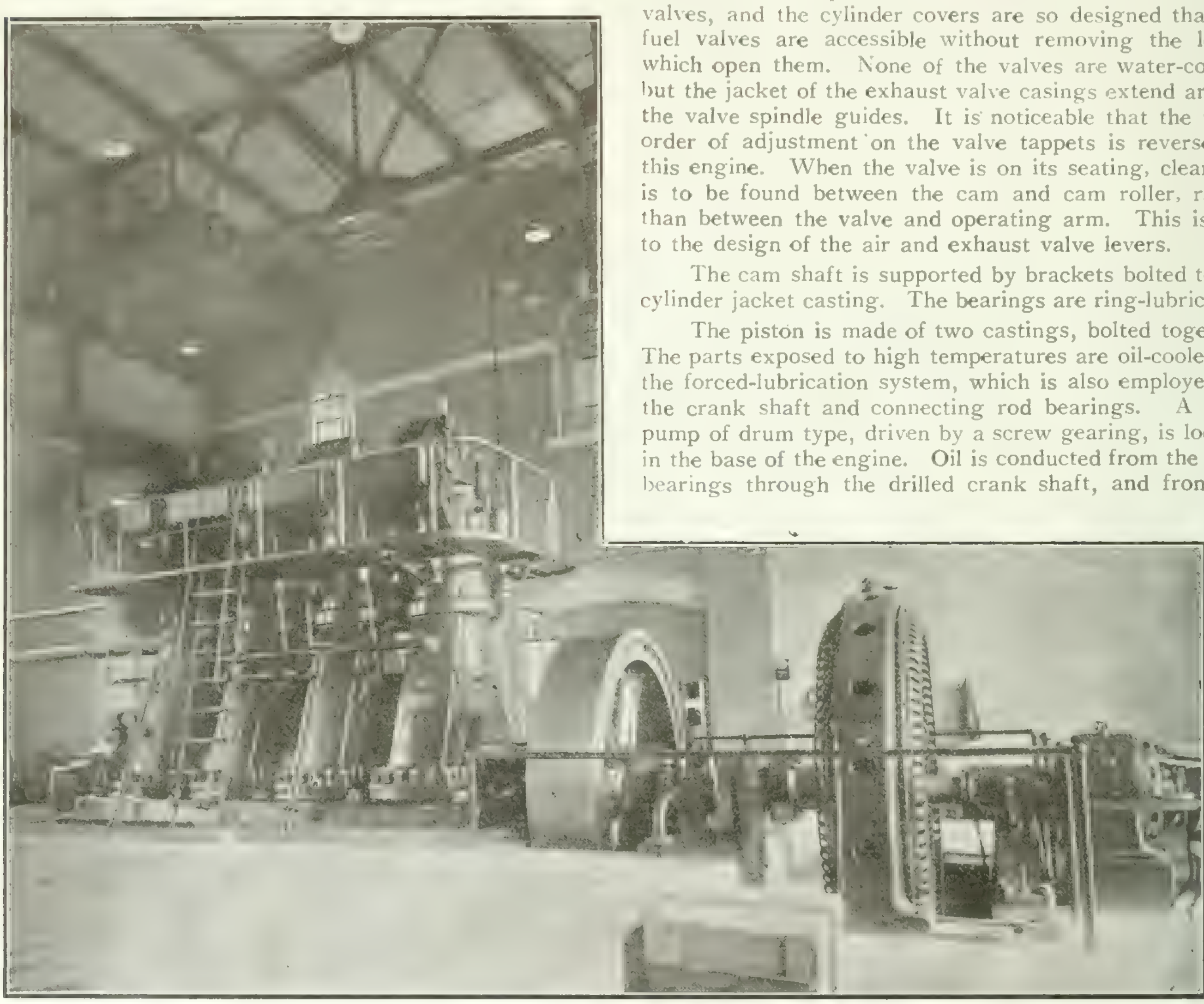

Fig. 2.—Interior of Power House, Showing Willans-Diesel Engine, Generator, Exciter and Suspended Feed Tanks.

shafts, controls the speed of the engine by timing the closing of the suction valve of the fuel pump, so that the actual quantity of fuel oil delivered to the cylinders meets the requirements of the load.

The compressor, for supplying the air required for starting and injection purposes, is a three-stage, quadrupled compressor of the Reavell type. It is driven by an overhung crank bolted to a flange coupling on the idle end of the main crank shaft.

The compressor has two low-pressure cylinders, 12-in. diameter, one intermediate cylinder 8-in. diameter, and one high-pressure cylinder, 4-in. diameter, all with a common stroke of 7 inches, and delivers the air to any of the receivers, which are three in number, for starting, reserve-starting, and running respectively. The starting receivers are piped to starting valves on two of the engine cylinders, the other two cylinders automatically operating on oil as soon as the speed is sufficient to give the requisite compression temperature to the air for ignition of the oil spray. The engine can easily be started and run up to speed ready for the load within one minute by one man.

frames, the whole superstructure being built of cypress, and securely bolted to the concrete tank.

To the engine is direct connected a 500-kw., 4,200-volt, 3-phase, 60-cycle generator of Swedish General Electric make, excited by a 11.5-kw., 115-volt exciter. The leads from the generator enter the sub-station through a tunnel.

Sub-station.—The generator switchboard consists of one panel, upon which are mounted a.c. and d.c. voltmeters and ammeters, integrating and graphic wattmeters, frequency and power factor meters and synchroscope, one of each.

The main switchboard consists of ten panels, viz., two main oil switch, two transformer, five feeder, and one totalizing meter panel.

The generator bus-bars are connected to the main bus-bars through knife switches, so that the generator panel may be entirely thrown out when the engine is not in use. The generator is so arranged that it can be run in parallel with the main system through their own transformers.

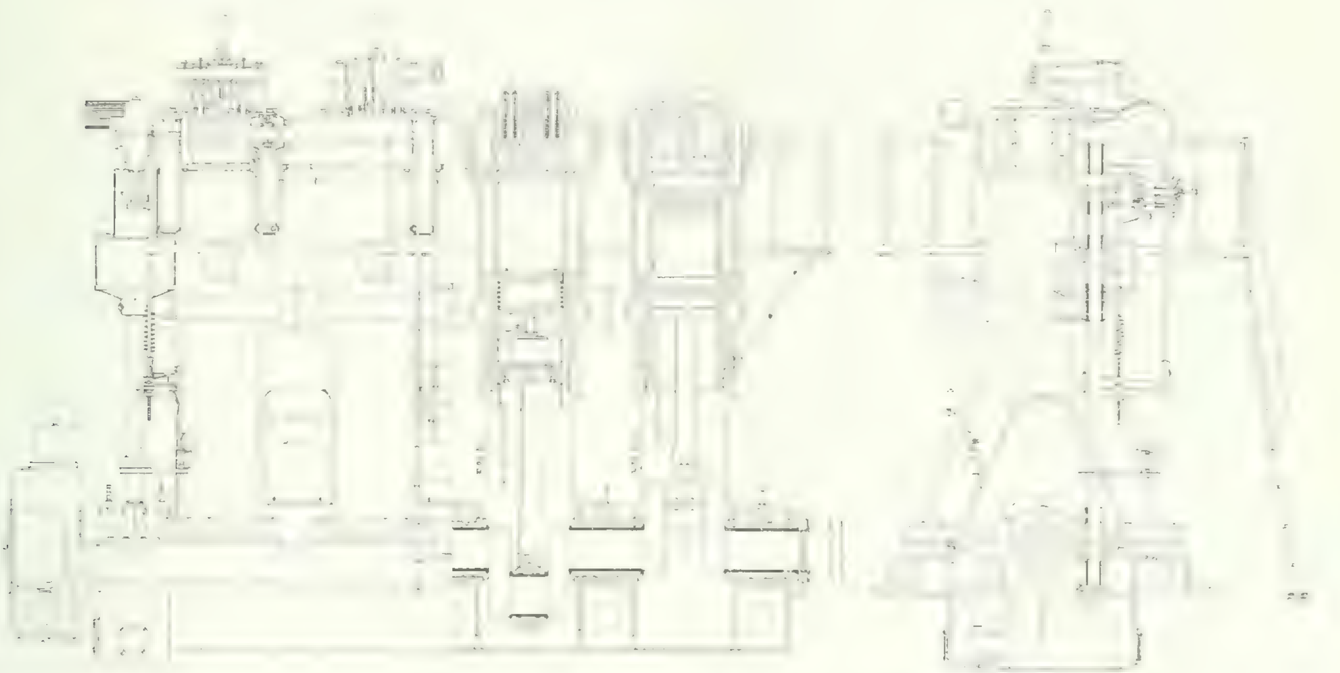

Fig. 3.—Elevations and Sectional Views of Engine.

The circulation of the cooling water is maintained by a rotary pump operated from the main shaft, the discharge being taken to the top of a cooling house mounted in a concrete tank in the yard. This tower is designed to avoid, as far as possible, the necessity of surrounding louvres structures to prevent waste by splashing, the water falling over stepped boards set in a series of A

The transformer room contains two 750 k.v.a. transformers with provision made for two more when needed.

Wm. Garnet and Sons, of Port Hope, Ont., were the contractors on the building. The engine was supplied by Willans and Robinson, Limited, Rugby, Eng.; the generator and exciter by the General Electric Company, of Sweden.

Recently many firms have transformed rope-driving into belt-driving systems, largely on account of the insufficiently criticized results of Kammerer. Experiments on a 200 horsepower plant are described. The ropes used for driving purposes are especially flexible. The efficiency of transmission has a mean value of 97.3 per cent. and increases with the load. Writing upon the subject in the *Zeitschr. Ver. Deutsch. Ing.*, lvii, 1911, H. Bonte says that few ropes are sufficiently stressed in practice. Rope driving properly applied is quite as efficient as leather belting, and probably more efficient than double or triple belts. It occupies less space and the initial cost is less.

At the Fosas mine in Sardinia a rather effective device is in use, permitting two buckets travelling in opposite directions to pass each other on the same rope. To the carrier of each bucket are attached 2 arms extending parallel to the track cable and above it. These arms are pivoted over the carrier, the one on the ascending side being kept elevated above the rope by means of a flat steel spring, while the arm on the descending side overlaps the rope and forms the track for the carrier coming in the opposite direction. The loaded descending bucket is, of course, placed at a higher level than the empty ascending one, enabling them to pass by means of the device described.

RESERVOIR STORAGE.*

By W. P. Mason,
Professor of Chemistry, Rensselaer Polytechnic Institute, Troy, N.Y.

At the outset it must be admitted that the advantages of water storage are many and the disadvantages but few. In those days when the expression "stagnant water" carried with it all sorts of ill-defined fears, the opponents of storage were easy to find, and their enthusiastic statement that "abundance of light and air is essential to the proper conditioning of water for human consumption" received very general support. He who drank of the rapid stream was accounted greater in wisdom than he who selected a less aërated supply.

It is now almost trite to say that still water, rather than running water, purifies itself the better, and it equally lacks novelty to point out that the more rapidly a stream flows, the sooner is its load of pollution delivered to the thirsty consumer. In that connection, let it be said that a great deal more depends upon the number of hours required for stream flow than upon the distance in miles between the intake and the source of pollution, and a concise statement giving information as to time of flow should appear in a report covering the sanitary survey.

Stagnation has its disadvantages, of course. Increase in color naturally follows if water be permitted to long remain in contact with a muddy bottom loaded with soluble extractive matters. Not only is damage to the water's physical appearance a result of such contact, but the material passing into solution is likely to furnish abundant food for those minute forms of life which carry objectionable tastes and smells to many public waters.

To the layman's ear the word "stagnant" has a most unpleasant sound, intimately associated with the production of disease; and yet its origin is innocent enough, viz., "stagnum," a piece of standing water, not running in a current or stream.

Pools so overloaded with vegetable growth, both dead and alive, as to be unfit for human drinking are plenty and they are commonly stagnant, but the ill-favored word does not properly apply alone to those; it is just as applicable to a water of crystal clearness resting upon a bed of sand.

The condition of "standing water" just referred to, namely, that of being overstocked with vegetable growths, is practically the only one toward which objection can point when considering the pros and cons of reservoir storage.

The word "vegetable" is here to be taken in its broad sense, as it should include not only those growths which would be recognized by the public at large, but also those of the minute world as well, which latter constitute one branch of that lake life known as "plankton."

As an instance of excessive overgrowth, a small lake could be named which is so loaded with dense vegetation that decay gets ahead of new growth, and the use of its water is productive of temporary diarrhœa. It is a stained water, but its color is not to be considered as a measure of its objectionable qualities for table use, as many waters of much darker tint are of excellent quality for such purpose. Color and fitness for drinking bear no relation to each other.

*Presented at the meeting of the Section of Physics and Chemistry of the Franklin Institute, January 29, 1914, and published in the April, 1914, Journal of the Institute.

It is true that colorless waters are now demanded by the people, and "meadow teas" are growing in disfavor, but that change in public opinion is of recent date and is not based upon established hygienic grounds.

The deepening in color of the lower layers of a water stored upon an unclean bottom; the encouragement of growths of small organisms producing taste and smell by reason of an accumulation of extracted food suitable for their development; and a deficiency in dissolved oxygen in the bottom levels, constitute the sum of objections that can be raised to the impounding of water, and they are much more than balanced by the advantages that accrue from such storage.

The pollution from shore drainage that reaches a reservoir water is likely to be naturally much smaller in quantity than that received by a flowing stream; nevertheless, very serious pollution may occur in concentrated form, even when the efforts of the caretaker are the most earnest. Thus, the writer has seen numerous loads of stable manure spread upon the very steep banks of a small, cup-shaped distributing reservoir. The intention in this case was good, and much pride was taken in the fine lawns of the waterworks park, but a better choice of fertilizer could have been made for such a location.

It is entirely possible to protect a reservoir, and to a great degree the watershed also, if careful policing of the district be established. Country towns situated upon the banks of streams tributary to the reservoir are the sources of greatest danger, and an earnest effort should be made to remove all privies, manure heaps, farm yards, refuse dumps, and other sources of pollution from draining into the stream or any of its feeders. This is sometimes difficult to accomplish completely, but a high degree of thoroughness can be attained by suitable and tactful management.

Board of health rules are expected to cover care of public watersheds, but rules and laws will not enforce themselves, and the city official is commonly at a distance and more interested in the distribution system than in that of collection. The most simple arrangement would seem to be to appoint a local physician in each town or village upon the watershed as the sanitary inspector for that particular district, and to give him authority to employ an intelligent laborer as a sub-inspector to do the necessary work under his direction.

The writer has found this arrangement both efficient and cheap. In one noteworthy instance, besides caring for the sources of pollution noted above, the sub-inspector's duty included the daily patrol of a mile of railroad track which ran along the border of the reservoir. This question of possible danger from railroad pollution has but recently been recognized. Although it is always well worthy of consideration, there is no question but that it greatly varies in importance with change in topography, soil, or season. Rocky, steep slopes are easily washed by the rain, and frozen embankments naturally fall into the same classification, while flat road-beds and sandy soils offer better chances for polluting material to be disposed of by natural methods.

Whatever the character of the road-bed, it should be the sub-inspector's care to remove all night-soil dropped from passing trains, and he should exercise greater vigilance in winter than during summer.

The physician-inspector would be in a position to know of cases of disease, such as typhoid, in his district and, being so informed, could take proper precaution against contamination of the public water, which act on

his part would be of vastly more practical value than a location of the trouble by some sanitary commission after an epidemic was well under way.

The greatest responsibility borne by the inspector, however, would be during periods when gangs of laborers were employed at construction work within the limits of the watershed. Should the workmen be many and the time of their remaining be two weeks or more, nothing short of incineration of all camp waste and night-soil should be demanded, and the utmost care should be taken that sanitary instructions were carried out to the letter. A Woodruff pit, which can be constructed in a few hours, would be suitable for a temporary camp; while, if something more permanent were demanded, a well-constructed incinerating furnace should be built.

When meadow lands are flooded, the extraction of food for plankton growth must of necessity take place, and we are forced to choose between stripping the proposed bottom or else depending upon the employment of some means of killing or removing the organisms that are likely to develop.

As to what could be done to rid a water of the odors due to algal and other growths, the outlook was not very hopeful previous to the appearance of the "copper sulphate process" proposed by Moore and Kellernan in 1904 (Bulletins 64 and 76, U.S. Bureau of Plant Industry).

The method of applying this chemical is simple enough, and its use is very efficacious. Bought in bulk, it can be had at about five cents per pound, and its distribution is readily secured by filling it into perforated buckets, or even bags, and towing the same by row-boat or launch over the reservoir surface.

Decided objection was raised against such a process of "disinfecting" a public water supply, and the opposition was especially marked in England, but the use of it is still with us and is likely to stay, for the reason that the "dose" is minute and is only occasionally required, that it is reliable in results, and that experiment has shown that it is not followed by the evil consequences predicted.

It must be remembered that it is not added to the water continually but is used only at stated and widely separated intervals, namely, at those times when the "crop" of minute organisms has become so well grown as to produce objectionable effect upon the water.

Perhaps one reason why the "coppering" of reservoirs has led to so much criticism is because of the dead fish that are to be seen after the chemical has been applied. When considering this effect upon fish life, one should bear in mind that the "dose" has of necessity to be applied uniformly over the surface of the water, and each acre of such surface presumably receives the same amount, irrespective of the depth of water that the acre covers. As a result, the shallow parts of the lake receive temporarily a greater quantity of the sulphate, per cubic foot of water, than do those which are deeper; again, the entire quantity of chemical intended for the whole body of the lake is delivered to a few inches of its surface layer; therefore, until diffusion has taken place, fish which chance to swim into such water receive a very concentrated dose and are likely to be affected by it. Distribution is complete by the time the water reaches the public mains, and, moreover, the minute dose used has been more or less completely disposed of through its action upon the organisms for whose destruction it has been employed.

In a paper before the Section on Hygiene of the Eighth International Congress of Applied Chemistry, 1912, Kellernan presented the following data:

Quantity of Copper Sulphate Required to Kill Various Forms of Odor-producing Organisms.

Copper Sulphate Required, Expressed as Parts per Million Parts of Water.

Anabæna	[illegible]	Kirchneriella	5. to 10.
Asterionella	.1	Leptomitus	.4
Beggiatoa	5.	Microspora	.4
Chara	.2 to 5.	Navicula	.07
Cladophora	1.	Oscillatoria	.1 to .4
Cladothrix	.2	Peridinium	2
Clathrocystis	.1	Scenedesmus	5. to 10.
Cœlosphærium	.3	Spirogyra	.05 to .3
Conferva	.4 to 2.	Ulothrix	.2
Euglena	1.	Uroglena	.05
Fragilaria	.25	Volvox	.25
Hydrodictyon	.1	Zygnema	.7

He adds a list of twelve genera of algæ that in his experience are causing trouble in reservoirs and ponds:

Number of Observed Cases.

Anabæna	27	[illegible]	[illegible]
Asterionella	9	Crenothrix	13
Beggiatoa	2	Fragilaria	19
Chara	26	Navicula	21
Cladophora	17	Oscillatoria	49
Clathrocystis	23	Spirogyra	43

Jackson claims that blue-green algæ will die if the water be "coppered" one part to five million. His dose for Mellosira or Synedra is one to two million, and he claims that the former gives no odor of growth, but only that of decay. He finds that coppering runs out certain forms of organisms and substitutes others by a sort of selective action, but those thus substituted are not likely to be odor-producers; and he further notes that, while "bottom" or decomposition odors are easily shaken out by aëration, "top" odors, viz., those of growth, have to be removed by filtering out the organism, or killing them by copper sulphate, or both. In his opinion, filtration of either type is effective for removal of odors of growth, but he believes that aëration would be worse than useless for living plankton, for the reason that the agitation would tend to mechanically release the oil causing the taste, which oil is not very easily oxidized.

Naturally the cost of treatment with sulphate of copper will depend in part upon the amount of the chemical that is to be used, which in turn is determined by the kind of organism that it is intended to kill; but it may be said that a mixed growth of Mellosira and Asterionella was removed from the Troy reservoir at an expenditure of 14.9 cents per million parts of water treated, labor included. The dose was one part of copper sulphate to 3,500,000 parts of water by weight.

In the article by Kellernan above quoted there are figures given indicating the safe limit for treating water with copper sulphate when certain fish are to be protected.

Copper Sulphate, Expressed as Parts, per Million Parts of Water.

Black bass	2.1	Pickerel	.4
Carp	.3	Suckers	.3
Catfish	.4	Sunfish	1.2
Goldfish	.5	Trout	.14
Perch	.75		

It must be noted that these figures assume a thorough mixing of the sulphate solution with the whole body of water. They would not hold for the unequal distribution and resulting local concentrations already mentioned.

In some reservoirs which have been formed by the extensive flooding of swamp bottoms there may develop objectionable growths of crenothrix, a general term denoting an aquatic plant which at times gives much trouble because of its tendency to develop in the street mains and

clog the pipes. It is often discovered quite unexpectedly, being dislodged by the current attending hydrant flushing or by the draft caused by fire engines. Dead ends are spots likely to harbor it, and its long, rusty filaments have been mistaken for horse manure.

There are three types of the growth, each possessing the peculiarity of precipitating from the water in which it grows its own particular metallic hydroxide. By far the commonest of the three is crenothrix kuhniana, which demands iron for its development and which deposits large amounts of iron hydroxide as the result of its growth. The iron required for growth must be in solution, and the quantity demanded would seem to be about 0.3 part of Fe per million.

In order that the iron may be in solution, we naturally would expect the dissolved oxygen to be low and the quantity of reducing agents, such as organic materials, to be high, and those are the conditions that we find in practice to be favorable to the development of the plant.

It is likely to be encountered in waters from swampy, peaty sources where dissolved oxygen is scanty and where the necessary iron in solution may be had. Driven wells in such localities frequently furnish it. Darkness favors its growth, and its development in city water mains is often excessive, resulting in a material reduction of the carrying capacity of the pipes. The writer has some doubt about the "manganese" variety of crenothrix being as rare as some think it is, he having found large quantities of manganese in a heavy Wisconsin growth. Beythien and others have, moreover, noted that the presence of manganese in water directly favors the growth of the ordinary form of crenothrix.

Beyond the mechanical stopping of street pipes, crenothrix is exceedingly objectionable to the laundry interests of the community, for the reason that its rusty filaments cause "iron stains" to appear upon white linen.

Removal of the iron by oxidation and filtration is the best guard against troubles due to crenothrix.

It must not be sweepingly assumed that all the "plankton" life is to be rated as uniformly objectionable; quite the contrary, as a reasonable degree of it acts as a distinct help in maintaining the safety of natural waters. Thus we find "bacteria eaters," such as many kinds of ciliated infusoria, rotifers, daphnia and the like, feeding upon minute germ life, and doing so to our great advantage.

To quote from a translation by Kuichling: "The question is, what becomes of the great quantities of offal and excreta, the many remnants of decaying plants, the refuse of communities, and the finely divided factory wastes of every description, which find their way into our streams, even under normal conditions, if a large portion thereof is not consumed by the aquatic detritus-eaters and the omnivorous fauna before settling to the bottom?"

With a view to avoid the troubles arising from the undue growth of taste- and odor-producing organisms, the stripping of reservoir sites and the removal of a portion of the upper soil has been advocated and carried into practice. This, of course, entails very great expense when the surface to be stripped is at all extensive, as in the instance of stripping the Nashua reservoir supplying Boston. At Columbus, Ohio, such work cost $159 per acre.

In their report upon the probable cost of stripping the surface soil from the Ashokan reservoir site, which is to hold the water supply for New York City, Messrs. Hazen and Fuller stated it would possibly reach the great figure of $5,000,000.

In view of the expense of such treatment for large reservoirs, the question is pertinent, "Does it pay?"

At Holyoke, Mass., the annual water report for 1908 says: "Great care had been taken in cleaning and stripping the reservoir by removing all vegetable and organic matter, thus lessening to a minimum the food supply for supporting living organisms in the water. The thorough cleaning of the reservoir has not been wholly successful, as an aquatic plant known as 'Chara' has grown and flourished in the reservoir all summer and imparted to the water a taste and odor that made it unfit for drinking or even for cooking purposes."

Mr. J. M. Diven ("American Water Works Association," 1908) has had interesting and contrasting experiences with both stripped and unstripped reservoirs:

The Elmira reservoir was as thoroughly stripped as possible; great care was taken to keep out the first washing from the drainage area and the muddy flood waters. There was little or no marsh land on the drainage area, the catchment area being seemingly ideal. The reservoir was clean and clear; on the sides the slopes were abrupt, and there was very little shallow water.

"At Charleston, S.C., the drainage area was largely swamp, and there was much decayed vegetable matter on all of the area drained, the water being decidedly peaty. The reservoir covered a large surface, was shallow, and absolutely unstripped or even cleared. Much of the land flooded was composed of black muck or decayed vegetable matter.

"In the first case (Elmira) the conditions were at the first satisfactory and the water good for several years. But trouble from algal growth came in time and has steadily grown worse, in spite of strenuous efforts to remedy the condition.

"The second case (Charleston) was troublesome and unsatisfactory from the first, but has somewhat improved and promises to continue to improve."

The writer's experience leads him to advocate the expenditure of comparatively little money in the preparation of sites for large storage reservoirs, for the reason that, although thorough stripping will likely give immunity from algal growths for some years, yet freedom from the occurrence of taste and odor in the stored water may not last for long. Sooner or later there will be carried into even the most carefully cleaned reservoir enough food material to sustain a plankton growth of a density governed by the local conditions. Broadly speaking, an "old bottom" is better than a new one, because it is likely to contain less plant food; but the rule has many exceptions.

Even natural lakes are frequently seen "in bloom"—that is, loaded with minute life—and they so remain for a period during which their waters are not acceptable for domestic use. The character of the tributaries must be considered as well as the nature of the bottom of a proposed reservoir, for it is manifestly loss of money to improve the latter if the former can quickly replace much of what has been taken away.

For the sake of general appearances, if for no other reason, trees, shrubs and bushes should be removed. Dead, standing timber and fallen logs are most unsightly and are very likely to produce complaint from the visiting public. In other words, the reservoir site should be cleared and grubbed, with, of course, entire removal of every vestige of human habitation; but beyond that it scarcely pays to go. The portion of the flooded land lying between high-water and low-water marks should receive especial attention, for the reason that during the

periods of its exposure it is capable, if uncared for, of presenting an unpleasant appearance and provoking adverse criticism; with the further objection that heavy weed growth may develop if it be long uncovered, which growth will contribute toward the production of taste and smell when the water again covers it.

In an instance where it was proposed to restore a dam that had been out of repair for over fifty years the writer advocated the cutting off of the standing dead timber at the existing water level before closing the breach, in order to insure a better looking sheet of water when the reservoir filled. This was for appearances only, as all extractive matter had been leached out of the old vegetation long before.

Aëration, filtration, and the judicious, occasional use of copper sulphate constitute the processes at our disposal for combating the annoyance arising from algal growths, and their use will give greater satisfaction than the expensive stripping of reservoir bottoms, a treatment which was so frequently advocated in the past.

Dr. A. C. Houston, of the London Metropolitan Water Board, has undertaken some very extended researches upon the question of water purification as a result of storage. He found that in stored Thames water the death of typhoid bacteria took place rapidly, although the rate varied with the temperature of the water. In cold water they lived longer than in warm, and 50° F. seemed to be a critical point above which their mortality rate was much increased.

In his 7th Research Report, Houston states that typhoid bacilli lived in stored raw Thames water for the following lengths of time: At 32° F., five weeks; at 41° F., four weeks; at 50° F, three weeks; at 64° F., two weeks.

Even these figures do not tell the entire story. Put in more detail they read:

	At start.	One week.	Two weeks.	Three weeks.	Four weeks.	Five weeks.
32° F.	[illegible]	[illegible]	[illegible]	[illegible]	34	[illegible]
41° F.	103,328	14,894	26	6	3	—
50° F	[illegible]	[illegible]	14	3	—	—
64° F.	103,328	39	3	—	—	—

He concludes: "It is difficult to escape the belief that thirty days' storage of river water is tantamount to sterilization, so far as the microbes associated with water-borne epidemic disease are concerned."

When experimenting with an artificially infected water to determine the effect of storage upon the typhoid bacillus, Dr. Houston felt that any error so introduced was upon the side of safety, because he had previously shown the "cultivated" typhoid organism to have a greater longevity than the "natural" *Bacillus typhosus*. In his report he dwells at length upon the advantages to be derived from "adequately storing the *raw* impure river waters." Even if there were no economic reason for storing a river water before rather than after filtration, yet it would be well to follow that course, aside from any question of algal growths, for the reason that sedimenting silt greatly assists in bacterial removal. Placing the word "raw" in italics was, therefore, a matter of good judgment.

Dr. Houston adds: "I am well satisfied that a well-stored, rapidly filtered water is likely to be safer than an unstored, slowly filtered water."

It is possible to go even further than this, for one can see how dangerous it might be to deliver, directly to the consumers, the water of a small and apparently pure mountain stream. The dejecta of a single typhoid carrier would render so small a volume of water highly infectious, if no storage intervened, and an outbreak might follow, such as occurred at Plymouth.

Although Dr. Houston is doubtless sound in his judgment that a great measure of safety will result from four weeks' reservoir storage of a polluted water, yet we must be assured that the period of storage is real and not simply apparent; or, in other words, we must know that *all* of the water really does remain in the reservoir for the specified length of time before it is used for public consumption.

Where the inlet and outlet of a reservoir are near together, as is not uncommonly the case, it makes but little difference what the capacity of the total storage may be; the water simply slips in and out again with practically as little stay as though the reservoir was a standpipe.

If the lake be long, narrow and deep, and all of its water be obliged to traverse its entire length before being taken for supply, then the conditions would appear ideal for purification of the inflowing water before the outlet was reached, and yet even under those excellent conditions it is possible to have introduced unexpected and upsetting factors, as is instanced by the history of the typhoid epidemic at Auburn, N.Y.

Lake Owasco is one of the so-called "finger lakes" of western New York. Its length is about ten miles, breadth one mile; its watershed is about 190 square miles, and its depth is about 175 feet. A small stream enters its head, and Auburn, a city of some 30,000 inhabitants, has an intake located at the north end or foot of the lake and forty feet below the surface. The temperature of the water at that point in May, 1913, I found to be 42° F.

The peculiar feature of the case which has special interest here is the possibility of polluting material of fecal character being transported from a village near the head of the lake, down the inlet stream, and then northward for the entire ten miles of the lake's length to the Auburn intake situated near the lake outlet.

We have all faithfully held to the dictum that "sedimentation and time" are the great purifying agencies upon which to rely for the natural improvement of a once polluted water; and it takes a good deal of evidence to persuade us that sewage of a small village could make the trip down such a lake in a length of time and in such a manner as to dangerously affect the water of the lower end. Experimental data, however, have been secured showing that such a result can actually take place. Investigation showed the following facts: The village sewage was, of course, small in volume, but during the winter months it was deposited at several points upon the banks of the inlet stream and there it collected in a more or less frozen condition until the occurrence of the spring thaw, at which time there was opportunity for much accumulated fecal material to be washed into the lake in a state of suspension. There was also a chance of its being actually ferried upon cakes of ice, for the reason that certain privies were located upon bridges and fecal matter was dropped upon the very centre of the ice-covered stream.

As stated, the shape of the lake is long and narrow and its axis lies north and south. It must be further noted that the prevailing wind is from the south, with a tendency to blow the surface water directly toward the city intake at the north end.

By means of triangulation and the use of floats constructed so as to be moved by water currents existing at the different depths of from five to twenty feet, it was ascertained that the upper strata of water moved northward with the wind, as would have been expected. The

rate of this movement being ascertained, it was found that with relatively light winds the movement of the water down to a depth of five feet amounted to about three per cent. of the wind movement, while at lower depths this water movement diminished to as low as three-quarters of one per cent. of the wind movement. Thus, to quote from the figures of Mr. Ackerman, who made these tests, with a wind movement of six miles per hour the percentage which the water movement was of the wind movement was as follows: At 5 feet depth, 3.2 per cent.; at 10 feet depth, 1.74 per cent.; at 15 feet depth, 0.87 per cent.; at 20 feet depth, 0.75 per cent.

With a higher wind velocity the water also travelled with greater velocity, but its movement was then not so large a percentage of the wind movement. Thus, with a wind blowing 17 miles an hour the water movement at a depth of five feet amounted to but one and a quarter per cent. of that of the wind. From these data it was easy to calculate that pollution entering the head of the lake could make the trip to the foot of the lake in three days or less.

Knowing, as we do, from Dr. Houston's experiments, that cold water below 50° F. will favor the longevity of the typhoid fever bacillus, it is easy to see how entirely possible it would be for living germs to reach the intake in dangerous condition.

It will be noted how striking is the resemblance which some features of this case bear to the classic instance of the outbreak of typhoid fever at Plymouth, Pa., where the whole trouble came from the dejecta of a single individual being thrown out upon a hillside where it froze and accumulated for weeks and finally, upon the coming of the thaw of spring, was washed into a stream tributary to the city reservoir. This sudden washing of accumulated fecal material furnished in both of these instances a volume of pollution out of all proportion to the amount which would be daily derived from the contributing population during ordinary times of fair weather, and as a result it overtaxed and broke down nature's ordinary means of purification and protection.

There is no question but that this particular case, showing, as it does, the dangers that may arise from such winter accumulation, and showing further the possibility, under favorable conditions, of the transportation of such material over considerable distances in a lake, will cause many of us to materially amend our notions about the dependence to be placed upon lake and reservoir storage as a means of protection against the evils following water pollution. We should not trust to simple storage without a thorough knowledge of just how it is being accomplished. The writer has in mind an instance of a large lake some five miles in length which has a stream entering within one mile of a city intake, and, because of the entering water having a low specific gravity, there is a possibility of its flowing over the surface of the lake toward the intake whenever the wind is in the right direction. The great length of that lake is, under such circumstances, of small value for purification purposes.

All of this certainly goes to show that we should be cautious about banking too strongly upon the efficiency of reservoir purification under all circumstances, and it demonstrates the necessity of our being well acquainted with the conditions surrounding each individual case before venturing an opinion on the matter.

It should be noted here that, in judging of the bacterial efficiency of lake or reservoir storage, the interpretation of the results of an examination may be obscured by an increase in the total count of bacteria reported due to the disturbing influence of the spring or autumn "turnover."

In conclusion, permit a word to be added concerning the value of storage as a protection against spreading disease through the use of an "emergency" water supply. The underwriters very properly insist upon a sufficient fire service, which shall be available in the event of a temporary breakdown of the regular distribution system. It too often happens that upon such occasions a very inferior water is supplied by the "emergency intake," and as a result of its use there follows an outbreak of typhoid fever. Commonly, some old intake is allowed to remain in place for "emergency service," when pollution of the former supply has so grown in intensity as to force the authorities to seek a new source for public water.

Further fouling of this old supply goes on progressively as population increases, until after some years the water becomes practically dilute sewage. Suddenly some accident to the regular water system induces the authorities to open the old gates, and the result may be imagined.

Such has been the history of typhoid epidemics in a number of cities.

Storage for a sufficient length of time, supplemented, if necessary, by an appropriate dose of bleaching powder, will render even a poor water acceptable for emergency uses, and the reservoir capacity for such storage need not be large.

MILL CONSTRUCTION FOR ABITIBI PULP AND PAPER COMPANY.

It is proposed to have ready for occupancy by June 1 the paper mill building of the plant of the Abitibi Pulp and Paper Company at Iroquois Falls. It will be 500 feet in length and nearly 300 feet in width, being much larger than any of the other buildings now clustered around the edge of Iroquois Falls. It will be like the other buildings, of solid concrete construction, absolutely fireproof. Forty thousand cords of pulpwood are piled on the banks of the Abitibi and Black Rivers and tributaries waiting to be floated down the rivers to the falls when the ice leaves. It has been decided to keep a gang of 250 men at work in the bush during the summer months cutting wood on the large reserve of the company. The total now cut awaiting the spring freshets will be increased by thousands of cords of settlers' pulp, to be shipped in by rail. At the plant at Iroquois Falls 475 men are now employed, with 250 men in the bush and at the Couchiching Falls dam.

Contracts are being signed for the equipment of the paper mills, while contracts for the paper machines have already been signed. These will consist of one 204-inch machine, manufactured by Walmsley, of London, England; two 188-inch and one 158-inch machine, manufactured by Pusey and Jones, of Wilmington, Delaware.

American copper mines turned out 218,579,133 pounds last year, or 1,901,380 pounds less than in 1911, but the value ($36,065,556) was $8,505,482 greater.

The London *Standard* states that a new alloy of exceptional lightness, considerable mechanical strength, and freedom from electrolytic action, is stated to be gaining popularity in British engineering circles. It is named "Ivanium." This alloy, obviously one of aluminium with one or more metals occupying positions, relatively near aluminium in their electrochemical properties, is only 2½ per cent. heavier than pure aluminium. It is stated to have the property of retaining its hardness after being subjected to heat, and of being non-magnetic. When polished, the surface remains bright indefinitely. Castings made in ivanium are stated to be equal in finish to the finest gun-metal. The alloy does not clog a file, and it can be screwed, tapped, milled and soldered with ease. Joints soldered together are stated to be as strong as the original metal. The melting point is low, about 300° C., and the alloy is claimed to be a useful deoxidant.

THE MEXICAN OIL INDUSTRY.

With the present complications which pervade Mexico, and particularly the vicinity of Tampico, it is very gratifying to be assured that the oil operations there are well removed from danger. The safety of workmen and of storage has been given much attention by Secretary of State Bryan, and his satisfactory assurances to ambassadors of other countries that no danger to the oil operatives ensued, brings an atmosphere of relief.

There are many interesting particulars connected with the Mexican oil industry. Some of them were given in a lecture delivered recently by Mr. R. P. Brousson, in England.

Dealing first with historical features, he mentioned that some oil-springs near Papantla were discovered in 1868 by Dr. Autray, who tapped them by tunnelling into the side of the hill from which the oil exuded. He set up a still, and for some time supplied the local demand for illuminating oil, but the enterprise did not prove profitable, and was eventually abandoned. Many more or less productive wells were drilled by different concerns between 1880 and 1904, but production on a really large scale did not commence until 1907, when Mexico first figured in the world's production statistics with 1 million barrels. At the present time the whole production of the country, which last year amounted to 23 million barrels, comes from twelve fields, six of which, controlled by the Pearson interests, account for about half the total output. Mexican oil is of an asphaltic nature, and that obtained from the north of Tampico has a high specific gravity, and is of such high viscosity that it cannot be economically pumped through pipe-lines. The quality of the oil, however, seems to improve more and more towards the south; at the southern end of the northern belt, for instance, an oil is found with a specific gravity of 0.894, and a viscosity of 143 seconds (Redwood) at 100 deg. Fahr. In the Isthmus of Tehuantepec, or southern belt, representative oils have specific gravities of 0.881, 0.852, and 0.816, with viscosities of 108, 50, and 30 seconds, respectively. These oils contain large quantities of motor spirit and illuminating oil, and some of them are practically free from asphalt, a feature which greatly facilitates the manufacture of high-class lubricants. The Mexican Eagle Oil Company have chiefly devoted themselves to the southern regions, and have control of a very large quantity of middle-grade crude oil, together with practically all the fields producing the lighter oils. Their large refinery at Minatitlan is capable of dealing with 1,400 tons of crude petroleum a day, producing from it motor spirit, burning oils, lubricants, fuel oil, paraffin wax, and asphalt. Another refinery is under construction at Tampico, and will be in partial operation by June of this year; when completed, its capacity will be 4,000 tons a day. The oil is transported by the Eagle Oil Transport Company, which company has twenty large tank steamers, either in service or under construction. Ten of these vessels, among which is the San Fraterno, have deadweight capacities of over 15,500 tons. The lecturer referred to the very interesting method of loading these vessels at Tuxpan, where the water is too shallow for them to come in close to the shore. Pipe-lines have accordingly been laid on the bed of the sea for a length of about 1½ miles out, and these pipes are connected by flexible hose to the steamers lying at ocean moorings. By this means three or four vessels can be loaded at once from the storage-tanks and pumping-station on the shore. During 1913 more than 200 steamers were loaded in this way in an average time of 2½ days each. The lecturer concluded his interesting discourse by pointing out that the very rapid development of the oil resources of Mexico that has taken place, up to the present, has been confined to the State of Vera Cruz. He, therefore, thought that, as other States are known to be petroliferous, it was safe to assert that the oil industry of Mexico is now only at the beginning of its ultimate prosperity.

RAIL STATISTICS IN THE UNITED STATES, 1913.

Statistics have been compiled by the Bureau of Statistics of the American Iron and Steel Institute showing the production of rails in the United States during 1913, and comparing this production with that of foregoing years.

In 1913, there were produced 3,502,780 tons of rails of all kinds, against 3,327,915 tons in 1912, an increase of 174,865, or 5.2 per cent. Included in the total for 1913 are 195,659 tons of girder and high T-rails for electric railways, against 174,004 tons in 1912 and 205,409 tons in 1911.

The most significant feature of the bureau's report, is the comparison of manufacture of Bessemer and open-hearth steel rails. In 1906, when the maximum rail production was reached, the production of Bessemer steel rails amounted to 3,791,429 tons, while in 1913 the production had decreased to 817,591. During the same period the production of open-hearth steel rails had increased from 186,413 tons in 1906 to 2,527,710 tons in 1913, which is an increase over 1912 of 422,566 tons, or 20 per cent. Of the total production in 1913 about 72.16 per cent. was rolled from open-hearth steel, about 23.34 per cent. from Bessemer steel and about 4.50 per cent. from electric steel, old steel rails and renewed rails.

In 1913 nearly 29.9 per cent. of the rails weighing less than 50 lb. per yd., nearly 48.7 per cent. of the rails weighing 50 lb. and less than 85 lb., and over 87.2 per cent. of the rails weighing 85 lb. and over, were rolled from open-hearth steel, while in the same year nearly 41 per cent. of the rails weighing less than 50 lb. per yd., over 44.8 per cent. of the rails weighing 50 lb. and less than 85 lb., and nearly 12.1 per cent. of the rails weighing 85 lb. and over were rolled from Bessemer steel. In addition, in 1913, over 29.1 per cent. of the rails weighing less than 50 lb. per yd., over 6.5 per cent. of the rails weighing 50 lb. and less than 85 lb., and less than 1 per cent. of the rails weighing 85 lb. and over were rolled from electric ingots and old steel rails or were renewed rails.

PROGRESS OF GREATER WINNIPEG WATER SUPPLY LINE.

The preliminary work on the water supply line from Shoal Lake to Winnipeg has been thus far accomplished with general satisfaction. The frozen ground facilitated the making of accurate surveys and the locating of the line approximately on the preliminary alignment through a country almost impenetrable except in winter. A section 37 miles long was run between two points 38 miles apart, with a deviation of not more than 3 miles from the air line and with a perfectly uniform grade of 0.7 ft. per thousand except for two small river crossings.

The location is through a country about 60 per cent. of which is covered with small timber. Half the distance is in muskegs. The concrete aqueduct will be uniformly covered by a fill 4 ft. deep, and it is believed that the invert will at all points be in hard ground below the swampy stratum. A contract of about $1,000,000 has already been awarded for the construction of 96 miles of standard-gauge service track for the construction of the pipe line. This track will be built in accordance with standard specifications and will have 60-lb. rail on rock or gravel ballast, qualifying it for permanent service. Construction is being advanced on a $25,000 telephone line connecting the engineering and construction camps with the offices in Winnipeg.

The Canadian Safety Engineering Bureau has been opened in the Mail Building, Toronto, under the management of Mr. Riley Schenck, for the purpose of specializing in the scientific prevention of accidents and fires.

THE SIGNIFICANCE OF B. COLI IN WATER EXAMINATION.

By Joseph Race, F.I.C.,
City Bacteriologist, Ottawa, Ont.

WHILE too much importance has been attached in the past to the presence of B. Coli in water used for domestic supplies, it is regrettable that the pendulum is now showing a tendency to swing too far in the opposite direction. The paper of Geo. A. Johnson (Proc. Amer. Waterworks Assoc. 1913, pp. 399-455), of Johnson and Fuller, New York, is an illustration of this movement. The all too common practice of using arbitrary and empirical methods in the bacteriological examination of water is partially responsible for the present *status res*, and in this regard bacteriologists have only themselves to blame. As will be shown later, the mere presence or absence of B. Coli in an arbitrarily fixed amount of water may have no significance when considered without regard to other circumstances; and in attempting this we are merely opening the way for criticism. The Committee on Standards of the American Public Health Association (1912) evidently recognized the futility of such procedure when they recommended that quantitative estimations should be made of B. Coli. They add: "Qualitative results, when viewed superficially, may seem easier to obtain than, and quite as conclusive as, quantitative results; but detailed evidence shows that in general the quantitative tests are by far the most fruitful source of information." It would appear that the Committee might have gone further and deprecated the use of qualitative tests except under extraordinary circumstances. This procedure has also had a deleterious effect on those connected with sanitary work, and who, by reason of their lack of familiarity with the technique employed have accepted this sophism. The author believes that, even with all the assistance that quantitative methods of examination afford, it is often difficult to give a sound opinion on the hygienic quality of a water supply, and that it would be folly to revert to the older methods.

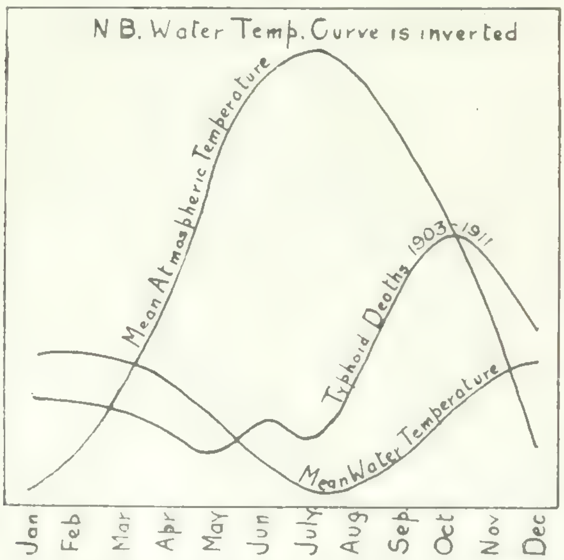

Fig. 1.—Showing Typhoid Deaths in Ottawa, 1903-1911.

There are many points of difficulty surrounding the significance of B. Coli, and on several of these the present knowledge is very meagre. Almost everyone is aware that B. Coli is common to the excreta of nearly all the higher and lower animals. In cold-blooded animals the occurrence is less constant, and more or less discordant results have been obtained. Dr. Amyot (Trans. Am. Pub. Health Assoc., 1901), concluded that B. Coli is not normal in the intestines of fish, and that when present it is due to the polluted environment. The tendency among animals generally is for B. Coli to become rarer as the zoological type becomes lower. None of the lower types, however, are susceptible to typhoid fever, man being alone in this respect, so that there is a possibility of having B. Coli unaccompanied by B. Typhosus. This B. Coli has, therefore, no significance.

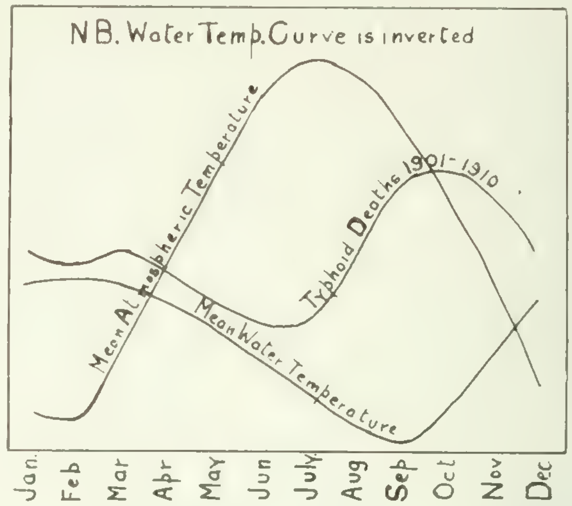

Fig. 2.—Showing Typhoid Deaths in Toronto, 1901-1910.

In reference to the B. Coli present in a water supply and due to human sources, it is important that information should be obtained regarding the total population on the watershed, the prevalence of typhoid and the probable period elapsing before the diluted sewage reaches the water services of the town under consideration.

The population is comparatively easy to obtain, and the typhoid death rate can, in most cases, be calculated from past records. In addition to the mortality, however, the case incidence should also be considered, as this has an important bearing on the probable ratio of B. Coli to B. Typhosus by its influence on the number of carriers. In Great Britain and certain portions of Europe the incidence is much lower and the case mortality higher than on this continent, so that the ratio of B. Coli to B. Typhosus is entirely different. It is possible that this ratio is ten times greater in North America than in Europe, and much greater significance ought, therefore, to be attached to B. Coli here.

The period elapsing between the discharge of the sewage and the withdrawal of the water is the most important factor, and in this connection the temperature of the water must be considered. Typhoid bacilli, in the absence of suitable food material, find an unsuitable environment in water, and, the cell energy being entirely of a katabolic nature, they die rapidly. It is obvious that this increases with the period of storage, and a consideration of the mechanism of the process also leads to the conclusion that the katabolic wasting increases with rise in temperature and vice versa. Dr. Houston and others have supported this hypothesis by numerous and conclusive experiments. It is important, therefore, that the bacterial contamination should be considered in its relation to the water temperature, and this leads to the conclusion that B. Coli should be regarded as having greater significance in winter than in summer. In the diagrams

illustrating this point the temperature curve has been inverted so as to conform with the viability of typhoid in water. In both the Ottawa and Toronto diagrams the typhoid death curve and the inverted water curve show a noticeable parallelism in the winter months, and as it is during these months that outside cases are at a minimum, the typhoid incidence is probably water-borne. The plotted figures for Toronto before and after the operation of the filtration plant show that it is this winter rate that has been reduced, whilst the summer prevalence, mostly due to imported cases, has remained unaffected. In Ottawa, with efficient sterilization with hypochlorite, only

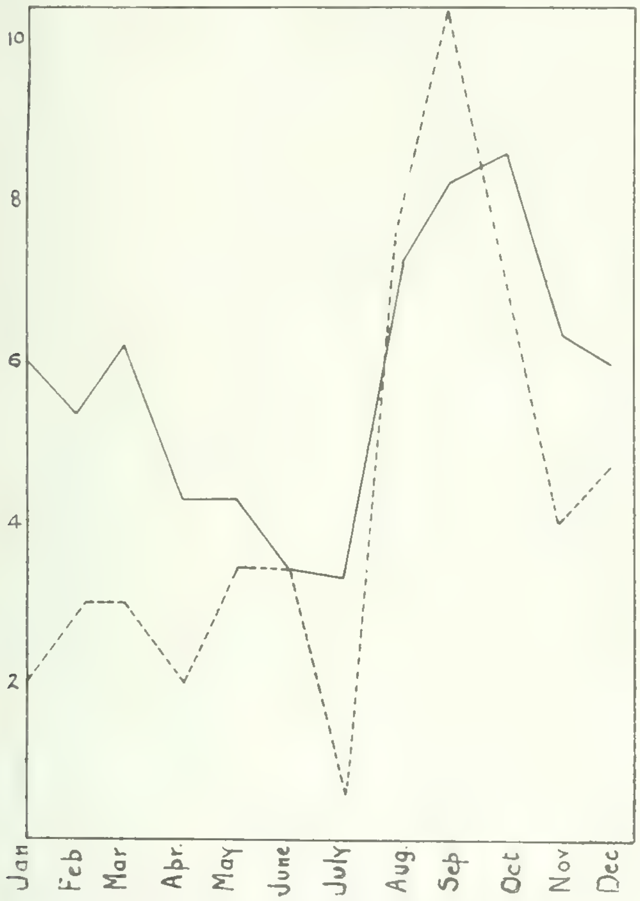

Fig. 3.—Typhoid Deaths in Toronto.—(Period 1903-11, before filtration, shown by full line; 1912-13, after filtration, by dotted line.)

one case of typhoid has been reported for the first four months of the present year. These results show what can be accomplished by water purification, and also that the significance of B. Coli must not be considered in an arbitrary manner.

Attempts have been made to belittle the value of the B. Coli test because the B. Coli content of the water supplies of certain cities did not bear a constant relation to the typhoid death rate. In such statements the sources of the typhoid incidence are not stated, and this, in many cases, may lead to erroneous conclusions. From the above remarks it is not to be expected that even typhoid rates due to water will closely correspond with the B. Coli content; all that can reasonably be anticipated is an approximate agreement. Cities with high B. Coli contents will tend, *cæteris paribus*, to high typhoid rates and the removal of B. Coli to decreasing rates. Let everyone remember that the B. Coli test is not a positive test for the presence or absence of pathogenic organisms, but an inferential test of danger and of potential injury to public health.

EARTH ROAD CONSTRUCTION.

THE following paper on the construction of earth roads was read by Mr. J. D. Robertson, Provincial Engineer of Highways for Alberta, at the 5th annual convention in March of the Alberta Association of Local Improvement Districts and Rural Municipalities:—

The necessity of permanent road construction in this province is becoming more noticeable each year. A few years ago, when the country was more sparsely settled, the old natural trails answered very well indeed and even now, with the increased traffic, these trails, especially in the southern portion of the province, where the soil does not retain the moisture to any great extent, hold up under heavy traffic, but where the soil is of such a nature that it retains the moisture we find it necessary to grade the road, construct side and offtake ditches so as to remove the surface water from it, but in doing this, if we are not very careful, and even with the greatest care, we leave the road with an inferior wearing surface to that of the natural top soil with its mat of roots. This is the problem we have to face as the country settles and traffic increases. It is necessary to adopt a system of road construction whereby a wearing surface will be obtained, that when properly maintained, will reasonably withstand heavy traffic. This result would no doubt be very easily obtained in many provinces of the Dominion but Alberta being an entirely agricultural province, and the soil being the very best for farming purposes, it is about as poor for road construction as it is good for agricultural purposes. We, therefore, will almost entirely have to depend on earth roads for some years to come, and should make up our minds to be content with them, for the best we can expect is possibly to top-dress with gravel or other material of a similar nature, a few earth roads, that will present a fair wearing surface where traffic is heaviest. But how much of this class of work can be expected when there are about 150,000 miles of road in the settled portion and about 400,000 miles of road allowance in this entire province?

You who have followed any of the reports, published by the Good Roads Congress or such like, especially in the east, will no doubt have noticed that the one thing they all agree upon is that earth roads are no good, and then go on and discuss macadam and other methods of road construction. In this province, instead of assuming their attitude, we have to build our roads with material we have at hand and in doing so, I think it would be safe to say the 95% of the roads constructed for years to come will be classed as earth roads.

In construction of earth roads there are at least three points which we should always bear in mind: (1) Proper drainage, (2) easy grades, (3) betterment of the road surface. The prevailing defect in earth roads is poor drainage and this defect is the first one which should be remedied. Drainage is for two purposes: (1) To remove water due to rainfall, and (2) to remove water which reaches the road by seepage from adjoining low wet land and which the road surface absorbs from underneath. To obtain the best results in surface drainage, I do not consider the side ditches should be over 24 feet from centre to centre of ditch and the roadway 16 feet in width with a crown of one inch to the foot. There are often opinions expressed that this is too narrow. I will grant that on a road leading into an important business centre, where the traffic warrants it, and 18-foot or 20-foot roadway is preferable, but the difference in the cost of maintenance of a 16-foot and 20-foot roadway is so great that, where

the traffic does not absolutely warrant the extra width, a 16-foot roadway is much more satisfactory as it is more liable to be kept in good condition.

Although the grade line of a road is very important, and a grade should not exceed 7% or where at all possible to obtain it, an easier grade should be found, still the grade line of the side ditches is much more important. How often have you noticed, especially where the country is slightly rolling and the work is done with a road grader, that great care is taken to carry the ditch through with a uniform depth. The bottom of the ditch is therefore the same distance below the surface of the ground, across the slight depression, as across the adjoining higher ground. The result is self evident, and after every fall of rain the side ditch instead of being a benefit to the road is a detriment. It would have been better not to have a ditch at all, for without the ditch the water would likely have run off, but the ditch prevents this and holds the water until it soaks into the road and forms a mud hole. Therefore, in my opinion, the grade line of the side ditches is by far the most important feature in earth road construction.

The next point that should be taken into serious consideration is the construction of offtake ditches. There cannot be too many of these. It is a poor policy to put in offtake ditches at long intervals and carry the water through the side ditches along the road. The quicker it is taken away from the road the less chance of injury to the road bed.

The same may be said about culverts. Where the road runs across the general slope of the country frequent culverts are necessary, it being a detriment to carry the water any distance along the ditch on the upper side of the road, for if this is done a large percentage of the water never reaches the culverts but filters under the roadbed and the consequences are soon apparent. Again in the case where the road follows with the general slope of the country, if the slope is too great the flow of water cuts away the roadbed and very often the ditches become so deep and the road so narrow that it is dangerous for traffic and, if the slope is not sufficient to carry the water away freely, it seeps under the roadbed, which is ruinous. In the first instance offtake ditches are required to reduce the volume of water that passes through the side ditches, and in the second instance they are required to remove the water more quickly from them.

Surface drainage is very often greatly interfered with by driveways leading into private grounds, or what we might call farm crossings, and especially if they are put in during a dry season of the year. They very often consist of a few poles thrown in the side ditch and covered with earth or possibly a load of manure or straw, in either case forming a dam. Of course, no doubt there are a great many who construct suitable crossings and it is to be hoped that the wisdom shown by them will lead others to follow their example.

There is one other point I would like to draw your attention to and that is the size of culverts used. The general tendency is to put in culverts which are too small to carry the water away freely, and in many places I have noticed the water level with the roadbed on the upper side of the road and the culverts running full. Too great care cannot be taken in putting in culverts of a proper size.

When it is desired to top dress an earth road with new material, care should be taken to secure it from the best available supply. River washed gravel is of very little use, as the pebbles are worn smooth and all the fine binding material has been removed by the action of the water. Even if clay or loam were mixed with river gravel, owing to the smoothness of the pebbles, it would not be nearly as satisfactory as material obtained from a gravel pit. Pit gravel frequently contains too much clay or earthly matter. Also very often the pebbles are of a uniform size, which is not suitable. The best pit gravel for road purposes should be composed of pebbles varying in size up to about 2½ inches in diameter and enough clay for a binding, so that the material may bond readily and if two layers are used the coarse material should form the bottom layer, then if there is sufficient binding in the material the finer particles will be washed down, filling the voids and good results will be obtained.

Top dressing 12 feet wide, averaging 4½ inches, would run about 880 cubic yards per mile and with a haul of one mile would cost $575 per mile in place with a three-mile haul would cost $1,000 per mile, with a six-mile haul would cost in place $1,750 per mile. This does not allow any charge for gravel, which might run as high as 25c. per cubic yard if obtained from a gravel pit of commercial value, nor does it allow any charges if shipped by rail, either for the extra handling or freight. In this connection I might state that no attempt should be made at top dressing a road until it is first properly crowned and ditched.

In conclusion, I wish to draw attention to the problem of maintenance. It is quite usual when a road is constructed to immediately forget about it, imagine it will last forever and look after new work. No matter how perfect is the construction of an earth road, whether top dressed with gravel or not, it requires constant care. The maintenance of earth roads is best accomplished by use of a split log drag or other implements of a similar device and if the drag is used with good judgment the cost is very little in comparison with the cost of repairing or reconstructing the road if allowed to go to pieces. Earth road repairs or reconstruction become unnecessary in proportion to the increased care in maintenance.

WATER POWER POSSIBILITIES IN ALASKA.

W. P. Lass, in an address on March 16, in New York City, before the American Electrochemical Society, declared that a proper development of the water power in south-eastern Alaska would be more valuable than either the gold mines or fisheries. He contended that the greater part of south-eastern Alaska, although undeveloped, unsurveyed and unprotected has been held in national forest reserves and little attention has been paid by anyone to its development and utilization. The present generation should use efficiently the great water supply of Alaska for power. It is an ever-flowing source of power that lost to-day can never be regained.

INTERNATIONAL CONFERENCE ON CITY PLANNING.

On May 25-27, there will be held in Toronto the International Conference on City Planning. Models, maps, plans and diagrams will be exhibited, illustrating the latest practice in Europe and America. Canadian cities and towns, and Canadian architects and engineers are cordially invited to send exhibits. All communications should be addressed to W. S. Lecky, Commission of Conservation, Ottawa, Ont. The exhibits may be classified under the following heads: Planning of Streets; Water Supply and Sanitation; Parks and Playgrounds; Waterways, Docks and Bridges; Railroads and Transit; Helping Industrial Prosperity; Garden Cities and Suburbs; Housing the People; Civic Centres and Public Buildings; Comprehensive Plans. Canadian social reformers will derive much benefit by attending this conference, listening to the addresses, taking part in the discussions, and by an inspection of the instructive exhibits that will be there shown.

SEWAGE COLLECTION AND TREATMENT IN PHILADELPHIA.*

By George S. Webster, Chief Engineer.

THE sewers of the city of Philadelphia as originally built discharged the crude sewage directly into the rivers and nearby streams, this not being considered objectionable at that time; but as the population increased and many tributary sewers were constructed, the smaller streams became seriously polluted and the Delaware and Schuylkill rivers, from which the city's water supply is taken, became so contaminated that in order to protect the public health it was necessary to take measures to alleviate the conditions.

The first work undertaken, commenced about the year 1883, was the construction of an intercepting sewer along the east bank of the Schuylkill River, from tidewater below Fairmount Dam to approximately the northern boundary of the city, with a main branch extending north along the Wissahickon Creek, thus keeping out of the water supply taken from the Schuylkill River all the sewage, collected in an extensive system of separate sewers, from Manayunk, Roxborough, Falls of Schuylkill and the portions of Germantown and Chestnut Hill lying in the Wissahickon and Schuylkill watersheds within the city limits. Recently an intercepting sewer has been constructed along the east bank of Cobbs Creek, to collect the dry-weather flow and first flush of the rain discharged from the combined sewers into that stream, which had become so seriously polluted as to be objectionable to sight and smell; and within the past two years an intercepting sewer has been built along the Pennypack Creek, in the north-eastern part of the city, to collect the sewage from the village of Holmesburg and from three large municipal institutions and convey it to treatment works, where it is purified sufficiently to protect the water supply taken from the Delaware River.

The city of Philadelphia has, therefore, what may be considered three systems of sewers: The combined system, which covers by far the larger part of the city; the separate system, which has been adopted in the areas adjacent to the portion of the Schuylkill River from which the water supply is taken, and the intercepting sewers along Cobbs Creek and Pennypack Creek.

The city is now engaged in the preparation of a comprehensive plan for the collection and treatment of its sewage, for submission to the state department of health, and the work which is now being constructed is in harmony with the plans which will be recommended. The investigations which have been carried on include a large number of studies of possible methods of collecting the sewage, the operation of a sewage experiment station, sanitary surveys of the water-courses and rivers, and the construction and operation of a plant to treat the sewage in one section of the city adjacent to the water supply. The magnitude of the problem will be appreciated when it is considered that the area of the city is 130 square miles, that it has a population of 1,650,000, and that the water consumption is approximately 200 gal. per capita daily; this, with the infiltrated ground-water from the older sewers, produces at the present time a large volume of sewage, estimated at 400,000,000 gal. a day.

The problem of sewage disposal in Philadelphia is twofold: first, to collect the sewage from the present system and abolish the nuisance which now exists in the large creeks and lower Schuylkill owing to the insufficiency of diluting water, and to carry it to distant points for treatment; and second, the protection of the public health by the treatment of the sewage, which is now and in the future will be discharged into the Delaware River, this treatment to be carried to such a degree that the drinking water can be safely and economically purified before delivery to the consumer.

It is of great importance, in preparing designs both for the collecting system and the treatment works, that relief may be given from the present objectionable conditions in the shortest possible time, that the work may be carried on economically and advantageously from time to time as funds become available, that each step taken may give some relief, and that it will not be necessary for the completion of the entire project before benefits may be obtained.

It was found early in the investigations that the cost of installing the separate system in those parts of the city already sewered on the combined plan would be prohibitive, for in addition to the cost to the city of laying sewage pipes in every street, the plumbing fixtures in all buildings connected to the sewer system would have to be rearranged so that the sewage and the rainwater could be carried in separate conduits. This latter expense, which would amount to many millions of dollars, would have to be borne by the individual owners.

In the design of sewers for the purpose of carrying sewage only, the factors used are the contributing population, water consumption and the amount of infiltrated ground water. It is quite common practice in many cities in designing sewage sewers to calculate that they shall run half full, when carrying a water consumption of 150 gal. per capita from the population tributary. To reach a conclusion as to the quantity of sewage to be treated by the city or Philadelphia in the future, and to obtain data for the design of the intercepting sewers, gaugings were made of the dry-weather flow of a number of main sewers, some of which were located in solidly built-up areas and others in partly built-up districts, and from the factors thus obtained estimates were prepared, based upon the probable increase and density of population, of the quantity of sewage that must be cared for in the future, the estimates and population curves being projected to the year 1950.

The amount of sewage flow determined by the gaugings in all cases included the infiltrated ground-water, no practical way appearing by which it could be differentiated from the sewage proper. As a majority of the sewers in which gaugings were taken are of considerable size and length, the variation between the maximum, minimum and average rates of flow is not as great as in smaller sewers. The mean of all the gaugings showed that the maximum flow was 128 per cent. of the average, and the minimum 78 per cent. of the average.

In addition to the flow of sewage, it has been decided to admit into the intercepting sewers, through automatic regulators, the first flush of the rain, which is usually as polluting as sewage, and the amount to be admitted has been fixed at 10 per cent. of the maximum dry-weather flow of the sewers, but a much larger percentage can be intercepted when the sewage is not flowing at a maximum rate. This additional 10 per cent. makes a storm maximum flow of 141 per cent. of the average flow.

When it is considered that the per capita consumption of water in Philadelphia is 200 gal. a day and that in the towns of England only about 40 gal. is used, it will be seen that by the arrangement proposed the degree of dilution of the sewage, in time of storm, compares

* Read before the Sanitary Section of the Boston Society of Civil Engineers, March 4, 1914.

well with the English practice of treating six times the normal dry-weather flow.

In studying the methods of disposal it has been found that the sewage may be treated with much less offense if it reaches the works in a comparatively fresh state before putrefaction has set in; therefore great care is being taken in the design of the sewer system that the velocity of flow shall not be less than that required to carry the materials in suspension. This is accomplished by providing proper gradients and by the exercise of care to secure smooth surfaces, avoiding all roughness and projections on the interior of the sewer where organic matter might find lodgment and be retained until putrefaction sets in and stench begins. Upon examination of many of the sewers in Europe there was no odor noticeable because the interior surfaces were smooth, either vitrified tile or smooth, glazed brick being used, and all connections so made as to provide a natural flow without the creation of eddies where deposits might occur. It is, therefore, recognized that a solution of a part of the problem of sewage treatment is to construct sewers with smooth interiors and to keep them clean and inoffensive.

In designing the collecting system, it is proposed to construct intercepting sewers at two levels, and in this way to utilize the potential energy in every foot of head and carry to the treatment works by the high-level interceptors the greatest possible volume of sewage, and thus reduce to a minimum the quantity to be pumped.

The collecting systems in many European cities are constructed so as to convey the sewage to one or more suitable locations for treatment, and care is exercised in their designs to secure the greatest economies.

Sanitary Surveys.—There are in Philadelphia five large creeks and the Schuylkill River, all of which are tributary to the Delaware River, which forms the eastern boundary of the city. Poquessing Creek flows through a territory but little developed, and is, therefore, not at the present time polluted. The sewage formerly discharged into Pennypack Creek and Wissahickon Creek has been intercepted and the water in these streams restored to a normal condition. A large part of the sewage on the Philadelphia side of Cobbs Creek has been intercepted and the condition of the water in this creek greatly improved. Frankford Creek, which empties into the Delaware River about five miles south of the Torresdale Water Filters, flows in part through a densely built up and industrial part of the city and receives crude sewage from about 140,000 people. It has several dams along its length, and, therefore, low velocities. The water is not only grossly polluted by the discharge of sewage into it, but the deposits of sewage origin upon the bed of the creek add to the nuisance.

The Schuylkill River flows through the city in a generally southerly direction, and about midway there is a dam which forms the end of tidal influence. The section of the river north of the dam has been protected within the city limits by intercepting sewers. Into the tidal portion of the river below the dam, however, there is now being discharged the sewage from about 455,000 people. At times of drought almost the entire up-stream flow is used for water supply, leaving a very inadequate volume of diluting water for the sewage from this large population. The examinations made during the summer months showed the water in this part of the river to be depleted of dissolved oxygen. Furthermore, the tidal velocities in the lower part of the Schuylkill River are insufficient to maintain the sewage matter in suspension, so that in addition to the polluted condition of the water, the putrefying deposits upon the bed of the river increase the nuisance, particularly in warm weather; but as in the case of Frankford Creek, above described, the natural sedimentation processes and the gasification of the resulting sludge, together with the refreshing action of the tide, lighten the load of organic matter placed upon the waters of the Delaware River.

The Delaware is one of the large rivers of the United States, and forms the natural drainage for portions of the states of Pennsylvania, New York and New Jersey. The normal flow of upland water is at the rate of 4.050 sec.-ft., in addition to which there is a tidal range of 5½ ft., and it is estimated that during the ebbing of the tide 2,421,000,000 cu. ft. of water flow past the city. As the sewage of the city at present and the effluent from the treatment works in the future must be disposed of in the waters of this river, its present condition has been examined with considerable care and it was found that with the exception of the docks, where sewers discharged, the Delaware River is successfully disposing of the crude sewage of the present population of Philadelphia in addition to that of the neighboring towns. Even in summer weather and in times of extreme drought, there has been no nuisance or offense created, although the amount of dissolved oxygen in the river has been small. The surveys indicated that the river water after passing beyond the points of discharge of the sewage of the city gained rapidly in its oxygen content. The high velocities, due to tidal flow in the river, maintain the sewage matters in suspension, and the examination shows that the entire bed of the river (excepting the docks) is clean and free from deposits of sewage origin.

It must, however, be realized that, with the increase in the population and the consequent added load placed upon the river, its oxidizing power will soon be overtaxed and that the time to begin the building of the collecting and treatment works is at hand.

Treatment Works.—The sanitary surveys of the water-courses in Philadelphia show that sewage must be excluded from tht creeks and the Schuylkill River, and that the treatment works must be located so as to discharge their effluents into the Delaware River in order to utilize to the fullest extent the great diluting and oxidizing capacity of that river.

It is proposed to locate the first treatment works in the north-east section of the city. The collecting system tributary thereto will eliminate the pollution of Frankford Creek and also prevent the discharge of crude sewage into the Delaware River within the tidal influence of the Torresdale Water Filters, which provide three-fifths of the city's water supply. The degree of treatment required at this works must, therefore, be based upon a hygienic standard in order that the public health will not be jeopardized by overtaxing the economical and safe operation of the water filters.

The second treatment works will be located in the south-west part of the city, near the mouth of the Schuylkill River, the most distant point within the city limits from the source of water supply. The collecting system tributary to this works will eliminate the pollution of the lower Schuylkill River and will result in concentrating the sewage from over half the population of the city at one point for treatment. As the effluent of this works will be entirely below the influence of the city's water supply, the degree of treatment required need only be sufficient to prevent nuisance in the Delaware River.

It appears to be economical to construct temporarily a clarification works in the south-east district, to care for the sewage now discharged into the Delaware River below the centre of the city.

Treatment.—In selecting methods for the disposal of the great volume of sewage produced in large cities, the adaptability of the various processes to a comprehensive plan must be considered so that the treatment works may be constructed by successive steps as needs arise for more refined treatment and as funds become available. It is desirable to obtain intensive methods, so as to secure a maximum of efficiency upon a minimum area of land, but in all cases exercising care to prevent nuisance from odors.

Various methods for the treatment of the sewage of the city of Philadelphia were studied, and those best adapted to the local conditions selected.

It has been frequently urged that the sewage of the city could be purified to advantage by applying it to farm land. Mr. John D. Watson, after years of experience, aptly states that this method of disposing of sewage "may be ideal in theory, but it is difficult, if not impossible, to obtain the ideal on a farm of large size." Berlin and Paris dispose of their sewage in this way, but, owing to the small volume of sewage which can be treated per acre, large areas of suitable land are required.

The Metropolitan Sewerage Commission of New York City has estimated that 175 square miles of land would be required to treat the sewage of that city if it were applied at the rate of 12,000 gal. per acre, and that the cost of this method of treatment would be $153,-000,000, and, therefore, dismissed it as being impracticable. The city of Birmingham, England, has abandoned its sewage farms and substituted the more intensive biological method, and the same course will probably be followed in Paris.

To treat at the present time the sewage of Philadelphia on farm land would require an area of approximately 60 square miles. To secure this amount of land in Pennsylvania adjacent to the city would be prohibitive on account of the cost, and would be opposed by citizens and property owners, hence this method of treatment need not be further considered.

London, the largest city in the world, with a population of 6,000,000 people, situated on the banks of a river with but little larger flow of upland water than the Schuylkill, disposes of its sewage by removing about 75 per cent. of the suspended matter by chemical precipitation and depends upon the oxidizing power of the river to accomplish its ultimate purification. That this is being successfully accomplished may be seen from the diagram which was prepared by Sir Maurice Fitzmaurice, late chief engineer of the London County Council, showing the percentage of saturation of the Thames River with dissolved oxygen, in connection with which he states: "With respect to the minimum amount of dissolved oxygen that should be present to prevent offense, it is rather difficult to answer this correctly, but I may say that the only complaint in recent years was for a short time in 1901."

While this method has been successfully used in London, it would not be applicable to Philadelphia, on account of the long haul to dispose of the sludge in the ocean, over one hundred miles distant. Another objection is the large quantity of sludge produced. From the best information available, it appears that the sludge, containing about 95 per cent. water, resulting from this method of treatment, amounts to 800 tons per day for a population of 500,000 people.

The city of Manchester, England, has probably the largest installation of contact beds. These are found to be expensive to operate and fail to produce an effluent up to the requirements of the Rivers Board. The concensus of opinion among experts in England seems to be that contact beds for a large installation are not as efficient as percolating filters.

From the results obtained at the Philadelphia Experiment Station and from the plant in operation at the Pennypack Creek, confirmed by the testimony of the city engineers who inspected a number of plants in Germany, it has been found that the two-story sedimentation tank, known as the Emscher tank, offers the best solution for the preliminary treatment of the sewage. The advantages are that the separation of the settling sewage from the digesting sludge maintains the sewage in as fresh a condition as it enters the tank, that it is equal in efficiency to any other type of tank in removing the suspended matter with shorter retention periods, and that the sludge withdrawn is without offensive odor, is smaller in volume than sludges resulting from other processes and more easily dried, and is so thoroughly decomposed that it resembles garden soil, and may be used for filling in low lands without nuisance.

It is the purpose to recommend for the north-east and south-west treatment works the following processes in sequence: Coarse screens to restrain the large floating objects, grit chambers designed to intercept the inorganic matter only, two-story sedimentation tanks of the Emscher type, and percolating filters or such other improved methods of oxidation as may be developed by the time this refinement is needed. All of these processes are so related that they can be incorporated in the work successively; each one is the most intensive of its kind, therefore a minimum amount of land will be required for the works.

At the South-east Works it is proposed temporarily to clarify the sewage either by fine screening or by the tankage method and then to discharge it without further treatment into the river. If a more refined treatment is required in the future the effluent from this plant may be carried to the South-west Works, where ample area is being provided for additional processes.

The full utilization of the diluting and oxidizing power of the river water largely depends upon securing a thorough mixture of the effluent from the works and the water of the river. At each of the three proposed treatment works for Philadelphia it is planned to accomplish this by discharging the effluent through submerged outlets into the main channel of the river.

The distribution of sewage over the surface of percolating filters is one of great importance, as efficient distribution will allow the use of high rates. At Bolton and at Hampton, in England, a travelling distributor is used. This requires but little head, but it is doubtful if it could be successfully used in countries subject to severe winter weather. At Wilmersdorf, Germany, and in a number of English plants, there are percolator filter installations in which distribution is effected by means of rotary arms. This method accomplishes good distribution, but has not been looked upon with favor in America. At Birmingham, distribution is through fixed nozzles operating under a constant head, and this method was followed in the early American installations, but it results in uneven application of the sewage. Latterly this has been improved by the use of the tapered dosing tank with syphonic discharge.

At the Pennypack Creek Works in Philadelphia there is in service a method of distribution through fixed nozzles, operating under a fluctuating head, which yields results equal to that from a mechanical distributor.

The Pennypack Creek Sewage Treatment Works.—As a part of the work of disposing of the sewage of the city and of protecting the water supply, a treatment

works has been constructed and is now in operation on the banks of the Pennypack Creek, which empties into the Delaware River 2,000 ft. from the Torresdale water filters. Into this creek there was formerly discharged the sewage of the village of Holmesburg and the large municipal institutions located nearby. Intercepting sewers have been built along the creek, and they conduct the sewage to a pumping station, where it is coarse-screened and passed through a grit chamber and then forced to the treatment works, one-third of a mile distant. The plant is designed ultimately to treat 2,000,000 gal. per day and at the present time it is receiving approximately 1,000,000 gal. daily.

The sewage first enters two Emscher tanks, which are of the radial flow type, 30 ft. in diameter and 32½ ft. deep, and having a normal retention period of 2½ hrs. The sludge is withdrawn from the bottom of these tanks through a pipe line, and is discharged by gravity upon a sludge-drying bed composed of layers of sand placed upon broken stone and under-drained by agricultural tile. Instead of the usual method of collecting the effluent of the Emscher tank into a dosing tank from which it would be discharged by a siphon upon the percolating filter, an equalizing tank has been constructed into which the effluent flows. The bottom of this tank is connected by a 24-in. cast-iron pipe with the distributing system of the percolating filter, and in this line between the equalizing tank and the percolating filter is placed a butterfly valve. The opening and closing of the butterfly valve is controlled by a cam, which is operated through gearing by a water-wheel driven by a small flow of Emscher tank effluent.

The shape of this cam was designed experimentally so as to make the spray from the fixed nozzles alternately move back and forth from the nozzle to a line which produces about six inches overlap of the sprays, and by this means a distribution has been obtained practically equal to that from a mechanical distributor.

To meet the variation in flow, due to the daily fluctation and to storms, the equalizing tank is electrically connected to the operating machine so that when the flow decreases and the level of the sewage in the tank falls to a predetermined elevation, the machine shuts down and the percolating filter is thrown out of service. When the flow increases and the water rises in the tank, a different cam from that generally in service is automatically thrown in, which causes a longer period of display of the nozzles and cares for the increased flow.

The percolating filter is one acre in area, and is divided into five bays, each having its own main distributor. Taylor square nozzles are used, spaced 10.8 ft. apart. The medium is 6 ft. of crushed trap rock, from 1 in. to 3 in. in size. Semi-circular vitrified clay underdrains are laid on a concrete floor, which slopes to the main effluent collectors.

As the function of this plant is the protection of the water of the Delaware River in the immediate vicinity of the intake of the Torresdale water filters, the state department of health required the disinfection of the effluent of the percolating filters, and a plant for this purpose was installed on the line connecting the percolating filters with the final settling basin, consisting of a mixing tank, which rests on the floor of the house and from which the bleach cream is forced by a centrifugal pump to either one of the two solution tanks. Before the bleach solution is added to the sewage it is diluted by a stream of water, and the very dilute solution flows through a lead pipe, perforated with a large number of small holes, and which lies horizontally in the channel carrying the effluent from the percolating filters. In this way a complete admixture of the disinfectant with the sewage is accomplished, and with only about 25 lbs. of dry bleach per day, which represents one part per million available chlorine, an almost sterile effluent has been produced. The records show that over a period of nineteen weeks only upon one occasion were B. coli found in the final effluent. After the sewage has been disinfected it is retained for about two hours in a shallow final settling basin and is then discharged into the creek.

The sewage as received at the treatment works is both fresh and dilute, and by keeping clean the surfaces with which it comes in contact, and by passing it through each of the processes as rapidly as possible, the plant is operated without any odor.

The grounds around the works have been made attractive by the maintenance of well-trimmed grass areas and by planting shrubs and flowering plants.

The sludge withdrawn has been low in moisture, generally about 75 per cent., has contained a considerable amount of gas, and each time it was withdrawn it has been found to be blacker and more granular, showing that the ripening period has been passed and that typical sludge has been obtained.

The final effluent as discharged into the creek has invariably been free from an appreciable amount of suspended matter, perfectly stable and nearly sterilized.

The work so far accomplished has demonstrated the feasibility of the methods suggested for the comprehensive treatment of the sewage of the city. The state board of health having been in touch with the work so far completed, it is anticipated that the plans to be recommended will meet with its approval; and it is hoped that funds will soon be available to commence the work on the larger installations.

AUCTION OF PULP LIMITS IN ABITIBI AND LAKE ST. JOHN.

Announcement has been made that the Quebec Government has decided to open new districts to lumber and pulp industries and will auction off limits in the Abitibi and Lake St. John districts during the months of August and October. In the Lake St. John region the territory to be opened is north of the lake and in basin of the Mistassini and Rat Rivers. In the Abitibi it is situated south of the Transcontinental, but on the north slope in the basin which empties in James Bay. This tract is traversed by the Poisson Blanc, Harricana and Belle Rivers. Both limits have been most carefully surveyed by the Forestry Service.

These concessions will call for the development of the water powers in the districts and will carry the obligation to construct pulp mills of a specified capacity within three years. The delay between now and August is to allow opportunity for exploration and permit of advertising the proposed auction, not only in Canada, but also in the United States, Great Britain and France, as the Government wishes to attract the attention of foreign capitalists to the great natural resources of the province.

The Government has appointed five official guides to further the interests of colonization in the Abitibi district and show settlers what that district has to offer.

A $2,000,000 corporation to provide electric power and lighting facilities for the Santa Ynez valley, the northern end of the county and all of San Luis Obispo county, has filed articles of incorporation at Santa Barbara, Cal., being the Midlands Counties Public Service Corporation. The present place of business is in Los Angeles. The company has acquired the power plants at Santa Maria, San Luis Obispo, Lompoc and other points, and plans for immediate extensions are being made. The new company is a subsidiary of the San Joaquin Light and Power Co. and power will doubtless be supplied by the immense plants of the San Joaquin company in the Sierra Mountains.

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CONTENTS OF THIS ISSUE.

CAMPAIGN AGAINST SMOKE IN ENGLAND.

There is a steady progress to the movement in Great Britain for smoke abatement and economy of fuel. During the past year much attention has been devoted to the publication of literature on improved methods for industrial and domestic consumption of coal, while the former side of the question, atmospheric pollution, is being followed up energetically. This spring some 15 of the largest cities have taken up the work of accurate measurement of smoke discharge, and it is expected that comparative records will have been obtained before the year ends.

One notable fact which the movement has brought to light in London is the rapid growth of the employment of electricity and gas for domestic purposes and the corresponding decrease in the use of coal.

It is stated that a bill will shortly be submitted to parliament whereby the existing laws may be consolidated, and another to extend disciplinary powers to local authorities against the emission of black smoke by industrial plants.

Four years ago educational classes for enginemen and firemen were inaugurated, under the direction of smoke inspectors of several cities. These have been very successful. The training of firemen is resulting in much encouragement to those who are attacking the smoke problem.

ECONOMY IN ROAD BUILDING.

The best form of road building economy is that which has for its basis the careful selection of a type of road or pavement that will best suit, during its entire lifetime, the conditions with which it has to contend. Analogous to this is the necessity, before any such selection can be made, for an exhaustive study of what those conditions have been, are, and are likely to be as long as the proposed pavement is in service. Then the exercising of judicious care and watchfulness over it, when laid, will prolong its usefulness; and, taken altogether, the result will be an economical piece of road building.

Occasionally one encounters, however, methods of figuring road costs that are instructive and that may be applied with comparative ease to an accumulation of data on costs of building, maintenance and repairs. An analysis of this nature might be expected to bring out interesting features which do not appear on the surface of the available road statistics.

An article appeared in last week's issue, which analyzed from a standpoint of 20-year economy the heavy traffic roads of some of the eastern States. It presented an interesting method of figuring road charges of one kind and another, e.g., capital, maintenance, renewal and interest charges. The results which were derived, however, bear a very marked dissemblance to those which Canadian practice has established, affording an excellent opportunity for a portrayal of that with which our municipalities are most concerned at the present time—the serviceability of Canadian roads and pavements.

It would be interesting for our readers to review the findings which *The Canadian Engineer* published in its issue of September 25th, 1913, as a result of an investigation into the whole subject of improved roads and streets in Canada. The returns from all the principal cities and towns, as summarized there, display a wide variation from the results which Mr. Trautschold derives in his treatment of certain conditions to be met with in New England. Where he has figured brick and stone to outclass

asphalt and wood block in the matter of relative 20-year economy when built under those conditions, with capital bearing interest at various rates per annum, road statistics in Canada, as indicated by the actual results obtained, are the complete reverse of his conclusions. This is so universally the case throughout the provinces that we find, as a result, for every mile of brick and stone pavements combined, there are two miles of wood block (chiefly treated, in which state it was introduced into Canada only ten years ago) and eight miles of asphalt pavement. In our cities there are upwards of 800 miles of paved streets, only about 50 miles of which are built of brick and stone. When one considers the special conditions in which these types present favorable characteristics, viz., where graded streets are to bear heavy traffic, where noise does not count, or where unsanitariness is not a factor (if such is anywhere the case nowadays) the proportion, 800:50, may not be far astray.

As stated, the economy of road and pavement work is chiefly a matter of choosing the best pavement to suit the conditions to be imposed upon it. Care in ascertaining the requirements, and in selection, with those requirements prominently in the foreground, are the essentials. Without them, no comparable results need be expected from the application of any formula.

Although the results would scarcely be recognizable when compared with Mr. Trautschold's, owing to entirely different conditions and quantities to be reckoned with, Canadian road engineers may apply to advantage the method of procedure laid down in the article referred to. From their own personal experiences, they will, of course, see the necessity of using figures that comply more strictly with their practice, (such, for instance, as the cost of maintenance) than those used in exemplifying the formula.

LETTER TO THE EDITOR.

Re "Some Large Concrete Bridges."

Sir,—In the article entitled "Some Large Concrete Bridges," beginning on page 698 of May 7th, 1914, issue of *The Canadian Engineer*, there are several slight errors and omissions to which I beg to draw your attention, in order that readers will in no way find the interesting article misleading.

For instance, in the opening paragraph of the article it is stated that "there has been a gradual increase in the length of the spans and length over all," etc. This statement is incorrect, as the longest concrete bridge was one of the first ever built. It was built in France prior to 1865.

In describing the Wissahickon bridge, the writer states that "prior to this all traffic had to make a wide detour," etc. He apparently overlooks the fact that there had previously been an old wooden bridge on the same site. Some of the largest recent bridges are not mentioned, such as that at Auckland, and the statement is made that the Riverside bridge was built contemporary with that at Walnut Lane, whereas it was actually completed two years before the Walnut Lane bridge was begun.

Further, it is stated that a recent bridge spans the Connecticut River in the city of Washington.

H. G. TYRRELL,
Bridge and Structural Engineer.

Evanston, Ill., May 12, 1914.

FIBRED ASPHALT PLANT FOR CANADA.

Geo. A. Henderson, of St. Albans, West Virginia, announces that a Canadian company has been organized to manufacture the new pavement "Fibred Asphalt," patented in Canada by Mr. Henderson last December. A $20,000 factory will be erected in Toronto in June, where graded hard-wood fibre will be impregnated. A test pavement, the first of fibred asphalt in Canada, will be laid in Toronto within a few weeks, the first ever laid being at Memphis, Tenn., in 1912. The Good Roads Year Book of the American Highway Association publishes the following:

"The invention relates principally to the art of denaturing hard-wood and preserving it in the following manner: A billet of hard-wood is shredded into small particles of ununiform lengths of 1½ inches down to wood flour, the flour itself being eliminated from the aggregate by screening. The particles are denatured by the process used by the tannin extract manufacturers, in which process all sap, essence and the more evaporable and deteriable elements in the wood are extracted, the remaining particles being thereby rendered abnormally enlarged and porous. In their subsequently dried and heated condition the wood particles, because of their porosity, are susceptible of impregnation, by absorption, by a non-deteriable, non-evaporating matter (such as asphalt), in lieu of the sap, etc., removed. The heating of the dried particles to prevent the premature congealing of the molten asphalt before reaching the particles' pores, has also for its object the partial contracting of the enlarged particles. The consequent contraction in the size of the particles' pores correspondingly reduces the amount of asphalt required to completely fill them.

"The wood fibre is a waste product of tannin extract manufacturers, who use hard-wood and no bark in their process. The particles are taken from the leaches on endless belts; dried, screened, heated and then mechanically mixed with a predetermined uniform percentage of asphalt, sufficient to fill the pores and voids in the mass when finally contracted and compressed. The material, in its partially impregnated and partially contracted condition is deposited at the mouth of its mixer into moulds 4 by 6 feet, these blocks being compressed on all sides only 3 to 4 inches, and allowed to cool, when they will remain intact for shipment, but are readily disintegrated in a breaker stationed at the front of a portable re-heating machine, designed to travel over the road to be paved, in which machine the coated particles are deposited and heated to from 250 to 275° F.

"This heating results in the final contraction of the fiber to its normal size, as it was before being chipped from its original log, and the entrapping of its asphalt content, thereby insuring penetration to the most minute pore of the fiber, thus thoroughly preserving it, without affecting its natural resiliency. The mass emerges from the rear of the re-heating machine in a continuous 18-inch flow onto the previously prepared road base, where it is mechanically spread 4 inches thick, steam roller compression immediately reducing it to a compact mass 2 inches thick. The interlocking of the ununiform preserved sinues of the hard-wood, in conjunction with the substantial penetration of the binding asphalt, in addition to surrounding the particles, is relied upon for durability.

"Fibred asphalt may be laid on any substantial foundation, such as old macadam, crushed stone, concrete, old brick, granite or wood blocks or cobble stones. For use on country roads a curb or shoulder is not necessary."

SOME FACTS ON REINFORCED CONCRETE.

By H. O. Hoffmann, Civil Engineer, Montreal,
Graduate of Polytechnic University of Zürich, Switzerland.

EXPERIMENTS which the writer has made lately in regard to construction in reinforced concrete and static analysis in general have prompted an elucidation of this matter from various points of view. First of all, one is confronted with the fact that men who appear to hold some distinction in their profession are often decidedly in need of clearness as to the correct distribution of the forces in the individual members of a structure. In order to guard against any eventual accidents, many designers are led to exaggerate the proper dimensions, with the result that not only less economical forms are obtained, but generally, also, there is no certainty of producing a secure structure.

This is one thing that tends to create prejudice against reinforced concrete as a reliable building material. Moreover, this method of tackling such problems is directly at variance with the whole science of the calculation of reinforced concrete structures, and hinders a due development which building in reinforced concrete has merited in other countries.

Careful studies in the designing of modern reinforced concrete structures have caused them to be classed as economical, since the specific qualities of the composing materials, concrete and steel, each in its place, are fully utilized. If these economical principles are neglected, reinforced concrete can never seriously compete against other building materials. To do justice to the proper designing of reinforced concrete, the designer must not rely only on a certain set of standard rules, as generally each construction requires an individual treatment in order to gain the most economical results, which in turn leads, in nearly all cases, to very simple structures. These, being very often statically indeterminate, may be computed only by a trained calculator.

A designer who is not versed in the statical analysis invariably commits the very fault described above, thereby increasing the cost of erection without rendering the structure safe. One need only repeat the warning given by Mr. V. J. Elmont, A.M.Can.Soc.C.E., in August 28th, 1913, issue of *The Canadian Engineer*, page 361, which reads as follows:

"This proves once more that the approximate figuring usually employed by designers without knowledge of calculating statically indeterminate structures, is nothing less than a menace to safe construction."

Furthermore, there is a stubborn disinclination against the employment of the plain round steel bars, and though these are much cheaper and more easily handled, all kinds of expensive patented bars of twisted, corrugated, etc., forms are mostly preferred. It is not the purpose here, however, to discuss the necessity of the employment of patented bars, or to show that this is based on an absolutely faulty assumption, for it would only be a recapitulation of the very statements given in the book written by Professor Moersch, formerly Professor in the Swiss Polytechnical University, whose treatise on reinforced concrete is widely known and favored by American civil engineers.

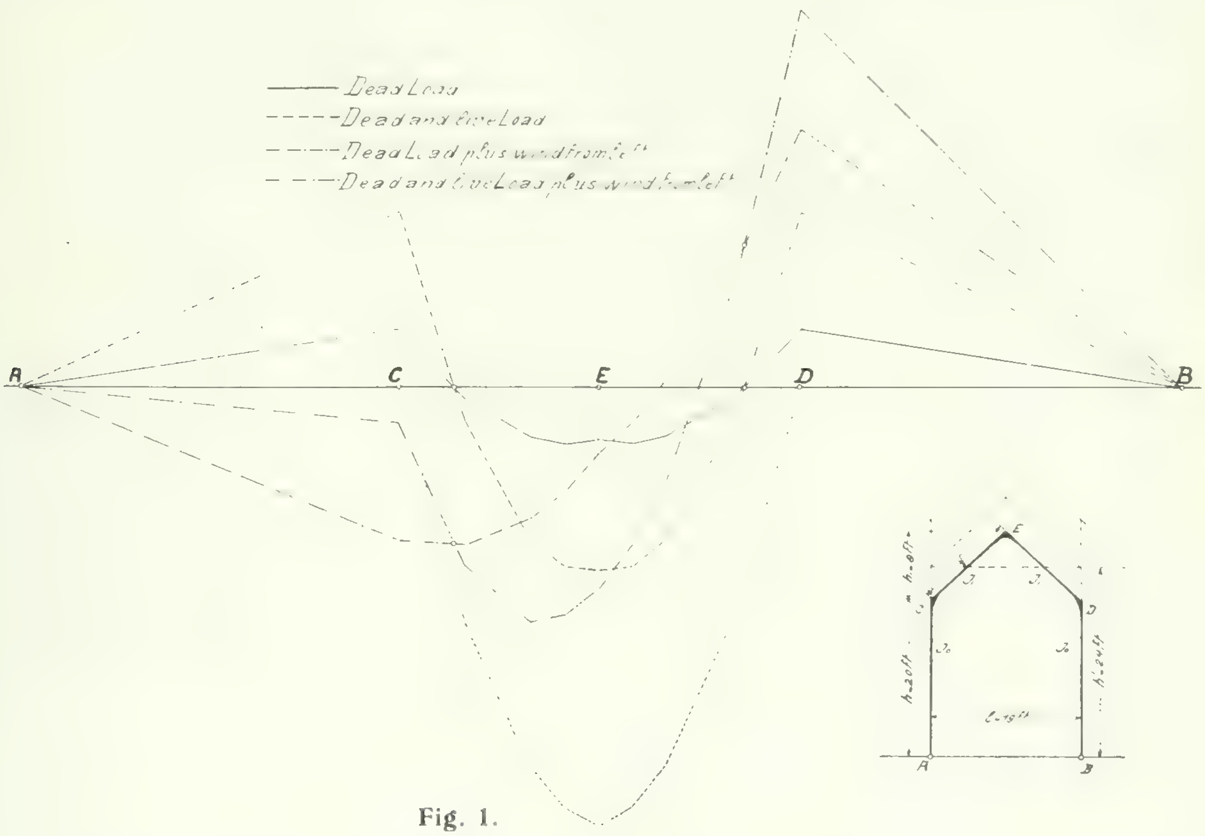


Fig. 1.

The following example, taken from practical experience, will tend to prove that only a correct statical calculation may enable us to utilize the advantages of reinforced concrete and successfully compete against a structure of steel. Moreover, if specific qualities are demanded, such as fireproofness, the most favorable room capacity, speedy erection, unlimited durability, omission of expenses for maintenance, etc., structures in reinforced concrete may claim the distinction of combining these

qualities in a greater degree than any built of other materials.

The writer does not consider the theory correct that the high cost and difficulty of securing skilled labor in this country forbid a more extensive application of this method of building. To contradict this, it may be stated that in the Balkans, he has succeeded in carrying out such work very economically, despite high cost of labor and extra expenses for specially skilled men. On other occasions he has, with wholly unskilled labor, accomplished very difficult work, employing the local natives, such as Wallachs, Albanese, etc. It may be added that the world famous firm, Hennebique, has used Egyptian Arabs, with whom they have effected good results on rather difficult pieces of work. It is simply a case of putting the right man in charge of construction, one who is of absolutely reliable character, and who thoroughly understands the whole system of building in reinforced concrete.

In Fig. 1, showing the bending moments, the elements of the moment are plotted on the laid-off axis of the frame. For the sake of simplicity, we substitute for the correct curve a polygon. The elements consist of: Dead load; dead load plus live load; wind from left plus dead load; wind from left plus dead and live load. The resultant of the maximum moments which is determinative for the dimensions of the structure will be found in the diagram for maximum bending moments.

In this case may be neglected also the longitudinal and transversal forces.

This method, however, was not comprehended by the gentleman for whom the writer designed the construction. Instead, he proposed the summary proceeding to distribute the weight on the transom, thereby presuming this

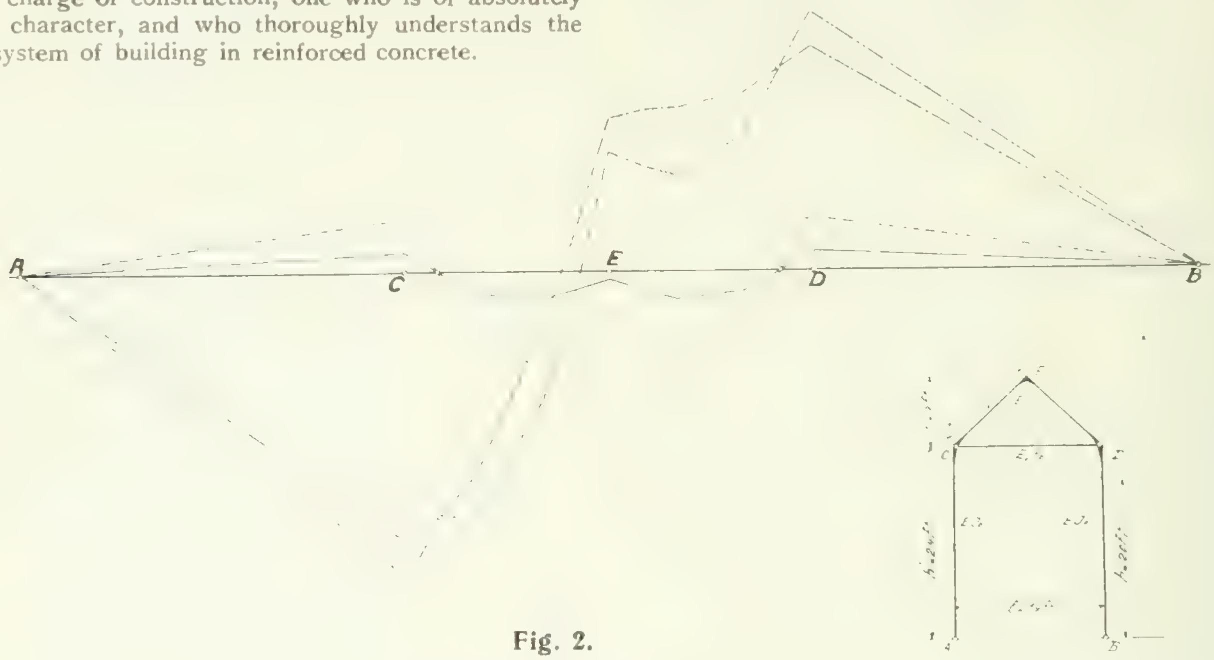


Fig. 2.

part of the structure to act as a plain beam, transmitting the weight to the two columns, which would have to be stiffened by the employment of a tension plate, and may be calculated as ordinary columns.

Such an assumption is absolutely arbitrary, consequently not in accord with the real circumstances. Proceeding in this manner, the structure does not only lose its monolithic character but the result is a mere farce of correct designing.

Realizing that the bending moment of the beam (dotted line in Fig. 1, for dead plus live load) amounts to more than twice the value of the moment in the vertex of the transom, it consequently requires more material for its erection.

Moreover, we cannot neglect the frame effect of the structure simply by assuming conditions which do not exist. Yet there appear important wedging moments, especially under the influence of a strong wind, whose effect must be considered. The posts calculated and constructed as plain columns could not stand these stresses. Thus the amount of material for erection of the frame is greater, yet the stability is more than doubtful.

If, to accommodate the "sense of statics" of such employers one takes refuge in putting in a tie, the height of the structure, in order to keep within the clearance limits, will be increased by 4 feet. With this method the frame becomes a double statically indeterminate structure, which has to be calculated as follows:

As a further obvious example of the advantages of reinforced concrete as a building material, it is to be noted that in the United States and other countries it is fast replacing other materials.

In the following case is considered a tender for double-track coaling plants with sand-house in reinforced concrete. This is taken as a typical example of such construction, particularly the supporting structure for the sand-house.

A two-hinge frame is proposed, as shown in Fig. 1. Such a structure is single statically indeterminate. As statically indeterminate value we insert the horizontal thrust X, and calculate with the aid of the rules of Castigliano for the smallest deformation. In this problem the insignificant influence of the normal forces and change of temperature may be neglected. We have then

$$\int \frac{M}{EI} \frac{\delta M}{\delta X} ds = O.$$

and becomes

$$X = \frac{\frac{I_1}{I_0}\int_0^h M_0 y . dy + \int_0^s M_0 (h+y) dx + \frac{I}{I_0}\int_0^s M_0 y . dy}{(\frac{I}{I})2\int_0^h y^2 dy + h^2 \int_0^s ds.}$$

We denote the statically indeterminate values: Suppose that the horizontal thrust on the support to be denoted by X_1 and on the spring of the transom by X_2, using the well-known formulas:

$$(1)\qquad \int \frac{M}{EI}\frac{\delta M}{\delta X_1}ds + \int \frac{N}{EF}\frac{\delta N}{\delta X_1}ds = O.$$

$$(2)\qquad \int \frac{M}{EI}\frac{\delta M}{\delta X_2}ds + \int \frac{N}{EF}\frac{\delta N}{\delta X_2}ds = -\frac{X_2\, l}{E_0 F_0}.$$

the two methods, unless we consider that the frame with a tie is 4 feet higher and has the same cross-section as the frame without a cross-tie. For the construction of the latter frame it cannot be considered that saving of material is of the first importance, but rather that reduction of cost for labor for the frame without a cross-tie inasmuch as the correct workmanship for the tension plate (which, furthermore, would have to be suspended from the vertex of the transom) would increase the cost of the structure, and for the handling of the storage owing to the greater height. All these facts are of more importance

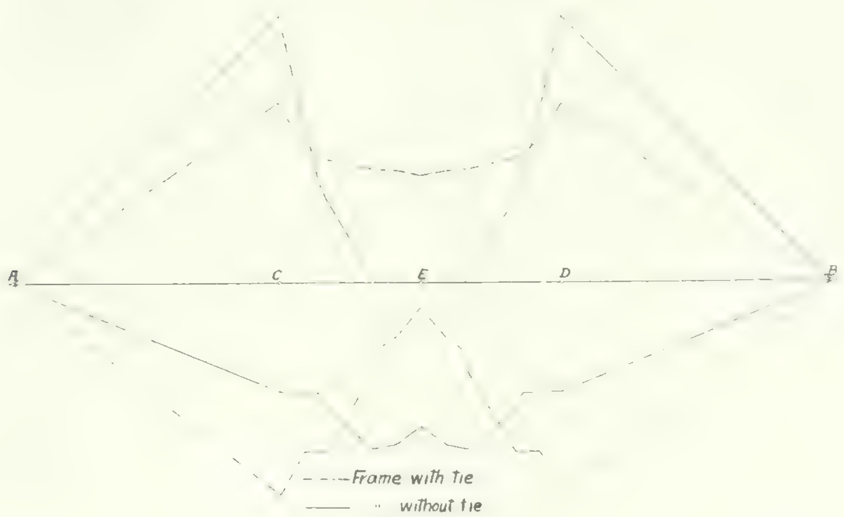


Fig. 3.

Notwithstanding the fact that the tie is embedded in concrete to protect it from the corroding effects of smoke, etc., and forms a part of the monolithic structure of the frame, the flexibility of the tie is not affected. This assumption has been found to be true on several similar constructions which the writer has designed and constructed.

Inserting in the equations the values of M, N, $\frac{\delta M}{\delta X_1}$, $\frac{\delta M}{\delta X_2}$, $\frac{\delta N}{\delta X_1}$ and $\frac{\delta N}{\delta X_2}$, for the individual members of the structure, we obtain:

$$(1)\qquad \int_0^h \frac{M_0 - X_1 y}{E I_0} y.dy + \int_0^h \frac{M_0 - X_1 y}{E I_0} y.dy +$$

$$\int_0^s \frac{M_0 - X_1(h+y) - X_2 y}{E F_1}(h+y)\,ds$$

$$-\int_0^s \frac{(X_1 - X_2)\cos\alpha}{E F_1}\cos\alpha\, ds = O$$

$$(2)\qquad \int_0^h \frac{M_0 - X_1(h+y) - X_2 y}{E I}\, yds$$

$$-\int_0^s \frac{(X_1 - X_2)\cos\alpha}{E F_1}\cos\alpha\, ds - \frac{X_2\, l}{E F_0} = O.$$

From these equations we may determine the two unknown values and find the moments shown in Fig. 2 again for all four methods of loading.

Comparing the curves for the maximum bending moments of both methods of calculation, there is at first no substantial advantage to be noticed adhering to either of

when we consider that such plants may be erected in quite a number of stations.

The above example is one of many tending to show conclusively that some structures in reinforced concrete may be designed on economical principles only with a thorough knowledge of statics.

COPPER AND SILVER MINING IN 1913 IN MICHIGAN.

Returns received by the survey in connection with mine production of copper and silver in Michigan in 1913 shows that the production of copper from ore mined in Michigan during 1913 was 135,853,400 lbs., having a value of $21,-[illegible], the copper being calculated at an average value of 15.5 cents a pound. The mine output was much smaller than the smelter production, as considerable material mined and milled previous to 1913 was smelted during the year. The production compares with an output of 218,1[illegible] lbs. in 1912, valued at $35,[illegible]. Due to the labor troubles which began July 23 and continued for the rest of the year, the output of all mines was greatly reduced in the latter half of the year, and several mines were not operated after July 23. The mines produced [illegible] tons of ore with an average copper recovery of 19.36 lbs. to the ton, compared with 11,411,941 tons of ore in 1912 with an average copper recovery of [illegible] lbs. to the ton. In addition to copper, the mines produced 205,17[illegible] ozs. of silver [illegible], compared with [illegible] 453 ozs. in 1912.

Writing upon the [illegible] of iron and steel in *Iron and Steel [illegible]*, [illegible] Mr. F. Rogers states that the crystalline structure frequently shown by wrought iron or steel which [illegible] repeated stress does not appear to be the result of fatigue, since in every [illegible] such failure [illegible] the author's notice, [illegible] fracture [illegible] [illegible] part of the metal. Examples of the failure of wrought iron are given in which such crystalline structures, in both the new and the fatigued metal, were due to the presence of [illegible].

STEEL PIPE MANUFACTURE.

THE following is a résumé of a lecture upon the manufacture of steel pipe, delivered by Dr. W. H. Walker, of the Massachusetts Institute of Technology, at a recent meeting of the American Chemical Society in Boston. The lecture reviewed the entire process of manufacture, from the sampling of ore at the mines to the testing of the pipe before shipment.

Iron is one of the most widely distributed elements in nature, but it is practically always found in combination with other substances, occurring largely in the oxide form. Chemically pure iron is extremely rare; its separation in the laboratory is a long and tedious process, and few engineers ever see it freed from combination with other elements. The production of pig iron in the United States has increased from 8,000,000 tons in 1896 to 31,000,000 tons per year at present. Forty-one per cent. of the total output comes from Pennsylvania, 23 per cent. from the Great Lakes District, 9 per cent. from Illinois, 4 per cent. from New York, and 6 per cent. from Alabama. The large coal deposits of Pennsylvania are important factors in the cheap local production of iron and steel. Some of the largest plants on this continent are the Gary, Ind., works of the Indiana Steel Co., the Lorain, Ohio, works of the National Tube Co., and the Chicago plant of the Illinois Steel Co.

The Lake Superior district is the largest producer of iron ore, and the Mesaba Range in Minnesota is the most famous present source of the raw material of the pipe industry. From the range to the steel mills of Pittsburg, the distance is about 1,000 miles. The ore beds are sometimes 600 ft. deep, with a heavy overhang. Steam shovels, efficient ore cars, excellent docking facilities and the loading of steamers by gravity are utilized to the fullest extent. An average steamer cargo of ore weighs 13,000 tons, and such a boat can be loaded in 31 minutes.

Unloading by cranes and multiple buckets consumes four hours. A modern blast furnace will produce 500 tons of iron in 24 hours, the furnace being 100 ft. high and 22 ft. in diameter at the bottom. To produce one ton of iron in a blast furnace there must be supplied eight tons of air, four tons of ore, two tons of coke and ½ ton of limestone. The furnace is tapped every four hours and the iron is tapped into sand molds or into ladles as conditions require. In a modern blast furnace 40,000 cu. ft. of air per minute is supplied at a temperature of 400 deg. C., and a pressure of 15 lb. per square inch. At Gary, all the gases of the furnaces are burned and enough power is produced by the gas engine and electric generating plant to operate the rolling mill, a cement plant and other establishments. Eight blast furnaces are installed at Gary.

From the blast furnace the iron is run into a metal mixer of 600 tons capacity, which reduces the casts from different furnaces to uniform temperature conditions, impurities being later removed in a Bessemer converter. When the iron has been purified by blowing air through the charge of metal in the converter, the charge is emptied into a travelling ladle and at the same time a certain amount of molten spiegeleisen is poured into the ladle with the iron to introduce into the metal a proper amount or carbon and manganese for the grade of steel required.

In usual practice a train of cast-iron ingot molds, with two ingots to the truck, is drawn by an engine beneath the pouring stand, and the hot metal is run into the molds through a nozzle in the base of the pouring ladle. As soon as the ingot is set, the mold is drawn from it by a hydraulic stripper, and it is lifted by an electric crane, and lowered into a soaking pit or heating furnace, where it is raised to the proper temperature for rolling. From the soaking pit the ingot is taken to the mill and passed through the blooming rolls, which reduce it in section reads for shearing into slabs and billets. Electromagnets are extensively used in handling billets. The billets in manufacturing pipe are re-heated and passed through a continuous mill consisting of a large number of rolls in pairs, placed one beyond the other at increasing intervals. As the billets or slabs are carried through each successive pair of rolls they are reduced in thickness and increased in length, until they issue from the last pair of rolls in the form of long, narrow plates called "skelp."

In the narrower strips, used for smaller pipes, the width is sufficiently uniform to eliminate trimming with shears, but the skelp for large pipes has to be carefully trimmed to the correct dimensions. In lap-welding, the plate is first laid upon a travelling table and has its edges bevelled. It is then heated in a bending furnace and rolled up into the form of a pipe with the bevelled edges overlapping. The material is heated and passed through concave welding rolls, between which a ball-shaped mandrel of a diameter equal to the interior of the pipe, is held in position by a long bar. As the skelp passes through the rolls the overlapping edges are squeezed together between the rolls and the mandrel into a perfect weld.

The rough pipe is then passed through sizing rolls and brought to the exact diameter required; then through the cross-straightening rolls, after which the pipe is rolled on a cooling table to prevent warping, and is finally forced by a hydraulic press through the dies of a straightening machine. The ends are then trimmed and threaded, and after being screwed into the couplings, the pipe is given various bending, torsional, flanging and compression tests in a hydraulic machine. If the weld breaks the pipe is scrapped. Lap-welding is now applied to larger pipe up to a maximum length of 15 to 18 ft., and a diameter of 20 in. Test pressures vary from 300 to 3,000 lb. per square inch. In the larger sizes the maker's name is rolled into the pipe, and in the smaller sizes it is stenciled upon the pipe. Boiler tubes are tested under the drop hammer by end-on blows.

In butt welding, the edges of the plate are left square. The skelp is heated to the welding point and is then drawn through a bell-shaped die, the diameter of which is a little less than that of the skelp. The pressure thus induced squeezes the edges together and makes a perfect weld. The smaller pipes are generally fitted with screwed flanges and couplings. Nothing is required in the interior of the pipe in butt welding.

The attainment of the proper temperature during the drawing process is vital to the success of the work. The larger pipes must be kept moving during butt welding to prevent sagging. There is a tendency for scale to run to the bottom and cause corrosion in butt-welded pipe. At the works of the National Tube Co. a method of overcoming this trouble has been developed for pipes up to 4 in. in diameter. The pipe is passed through rolls which pull it enough to loosen the scale, which then drops off. This treatment is of great value when a pipe is to be galvanized and has a future outlook, which is worth bearing in mind.

Anthracite coal shipments in the United States in the first seven months of 1912 were 40,330,7[illegible] tons, against 40,11[illegible],048 tons in the second year of 1911. The total production for the latter year was about [illegible] tons.

ROAD MAINTENANCE SYSTEMS AND METHODS.*

By M. O. Eldridge,
Ass't in Road Management, U.S. Office of Public Roads.

THERE is no phase of the road subject which is more important than that of maintenance. The impression is quite general throughout this country that there are certain types of roads which are permanent. This is a mistaken idea. No permanent road has ever been constructed or ever will be. The only things about a road which may be considered permanent are the grading and the concrete culverts and bridges, and even they may not be lasting.

Roads constructed by the most skilful and experienced highway engineers will soon be destroyed by the traffic, the frost, the rain and the wind unless they are properly maintained, but the life of such roads may be indefinitely prolonged by continuous and systematic maintenance. Even a poor road may be greatly improved by proper maintenance. In other words, a poor road with proper maintenance may become better, in time, than a good road without it. Damage to a road from traffic or weather may be repaired at its inception with a slight expenditure of time and money, but if allowed to go on without attention for a considerable length of time it will involve a heavy outlay for repairs, and even threaten the existence of the road.

Systems of Maintenance.—There are several systems of maintenance in use in this country, among which may be mentioned the intermittent system, the patrol system and the gang system. Under the intermittent system should be included the working of certain roads by toll-gate companies, and the maintenance of roads by contract and by citizens in working out their property and poll taxes. Under the patrol and gang systems should also be included the combination of the two systems.

The intermittent system is that under which roads are repaired or maintained spasmodically once or twice a year. This is the system, or rather lack of system, which has prevailed throughout the United States until within the past few years, and needless to say it is the one under which the poorest results have been secured.

There may be some reason for toll roads, but, on the whole, this system is un-American, contrary to the spirit of our free institutions, and has been found unsatisfactory. The reason for this is that the tax is too direct and burdensome to be borne by the road users alone.

The contract system has been used to some extent in various states, but has not been found entirely satisfactory. As a general rule, the work is let to the lowest bidder. The amount paid for the work is small, and such poor service is rendered by the contractors that in many cases the roads have become worse rather than better. Under proper engineering supervision and inspection, and with plans, estimates and specifications prepared in advance, the contract system of maintenance might prove as efficient and economical as in construction work.

Under the personal service or labor tax system no state, county, town or township has ever built or kept in repair a system of first-class improved roads. This system is not applicable to any class of road work, with the possible exception of earth road dragging, in sparsely settled portions of the country. The principle of working out the road taxes is unsound, unjust and wasteful, and the results obtained under it are unsatisfactory in many particulars. During the past few years many of the states have abandoned this method. It was abolished in France about 125 years ago. It is estimated that of the eighty million dollars spent on roads in the United States in 1904, approximately thirty million dollars was worked out, whereas, in 1913, of approximately one hundred and eighty-six million six hundred thousand dollars spent on roads, only about fifteen million dollars was worked out.

The patrol system is that which provides for the permanent employment of skilled laborers or care-takers, each of whom has charge of a particular section of road.

The gang system provides for the employment of a corps of skilled laborers, who may be assigned to any part of a county, township or town where the work is most needed. This system is particularly effective for bituminous-macadam repairs.

The patrol system has been used very successfully in France for over one hundred years, and there is no doubt that it would give satisfactory results in many of the most densely populated sections of this country. It has been used to some extent in Maine, New York, Massachusetts, Maryland, New Hampshire, Connecticut, Rhode Island, Pennsylvania, and in a few counties in various other parts of the country. Men who are constantly employed in this way become experienced in their particular lines of work. They soon learn to do the work well, and will take pride and interest in it. There is no doubt that in certain kinds of maintenance operations one man will accomplish more and better results in 313 days than 313 men will accomplish in one day.

The ideal system would appear to be a combination of the patrol and gang systems whereby the patrol men or caretakers look after their particular sections of road during certain seasons of the year, and at other times work together in small gangs. A parallel to this system is found in the maintenance-of-way departments of our great railways. These provide patrolmen and track walkers who look after small defects, and section gangs to do the work which requires more than one man's services.

The assignment of caretakers or patrolmen should be left entirely to the engineer in charge. In this way the system may be rendered more elastic and more efficient.

It would be impossible to adopt the patrol and gang system everywhere throughout the country, on account of sparse population and limited resources, but there are many communities in which it might be used. It is difficult to find a community which is so poor that it could not afford to employ eight or ten laborers and three or four teams continuously, and there are thousands of towns, townships and counties which could afford ten times such a force. That such a plan would be more efficient than the intermittent systems would appear to be self-evident.

In dealing with the subject of maintenance aside from its administrative features, the only wise and safe plan is to provide, after making careful estimates, for a cash appropriation sufficient to maintain every mile of new road constructed. Funds should also be provided for taking care of the old roads. These appropriations and expenditures should be kept absolutely separate from the construction fund, and if it is possible to do so the maintenance funds and the repair funds should also be separated. If a community can not afford to set aside a fixed and adequate sum for the maintenance of a high-class road, then it is doubtful whether it can afford to build such a road.

*Paper read at Maine State Road Convention at Bangor, April 8th, 1914.

Methods of Maintenance.—The methods to be employed under any system will vary with the type of road to be maintained and the character of traffic. To deal with these phases of the subject in a satisfactory manner would require more time and space than can be devoted to it in a short paper. This part of the subject will, therefore, be confined to a few brief suggestions regarding the best methods of maintaining earth, gravel and macadam roads.

Earth Road Maintenance.—The first and last commandment in earth road maintenance is to *keep the surface well drained.* To insure good drainage the ditches should be kept open, all obstructions removed and a smooth crown maintained. Except for very stony soil, the road machine or scraper may be used very effectively for this work. The machine should be used once or twice a year, and the work should be done when the soil is damp, so that it will pack and bake into a hard crust. Wide and shallow side ditches should be maintained with sufficient fall and capacity to dispose of surface water. These ditches can in most places be constructed and repaired with a road machine.

All vegetable matter, such as sods and weeds, should be kept out of the road, as they make a spongy surface which retains moisture. Clods also are objectionable, for they soon turn to dust or mud, and for that reason roads should never be worked when dry or hard. Boulders or loose stones are equally objectionable if a smooth surface is to be secured.

A split-log drag or some similar device is very useful in maintaining the surface after suitable ditches and cross-section have once been secured. The drag can also be used on a gravel road just as effectively as on an earth road. The principle involved in dragging is that clays and most heavy soils will puddle and set very hard when wet. The essential requisite, therefore, is that the work be done at the proper time. This is the point which seems to be the hardest to impress on the average man. The little attention that the earth road needs must be given promptly and at the proper time if the best results are to be obtained.

In dragging roads only a small amount of earth is moved, *just enough* to fill the ruts and depressions with a thin layer of plastic clay, which packs very hard, so that the next rain, instead of finding ruts, depressions and clods in which to collect, runs off, leaving the surface but little affected.

The drag should be light and should be drawn over the road at an angle of about 45 degrees. The driver should ride on the drag and should not drive faster than a walk. One round trip, each trip straddling a wheel track, is usually sufficient to fill the ruts and smooth out the surface. If necessary, the road should be dragged after every bad spell of weather, when the soil is in proper condition to puddle well and still not adhere to the drag. If the road is very bad it may be dragged when very wet and again when it begins to dry out. A few trips over the road will give the operator an idea as to the best time to drag. Drag at all seasons, but do not drag a dry road. The road will freeze smooth if dragged just before freezing weather.

The slope or crown should be maintained at about one inch to the foot. If the crown becomes too high it may be reduced by dragging toward the ditch instead of from it. If the drag cuts too much, shorten the hitch and change your position on the drag. If it is necessary to protect the face of the drag with a strip of iron, it should be placed flush with the edge of the drag and not projecting. A cutting edge should be avoided, as the main object in dragging is to *smear* the damp soil into position. The dragging of roads may be encouraged by offering to caretakers or patrolmen special bonuses or prizes for the best mile of road.

Maintenance and Repair of Gravel and Stone Roads.—The following suggestions may be found useful in the maintaining of gravel and stone roads. Culverts and ditches should be carefully inspected at frequent intervals and all obstructions removed. If the weeds are cut from shoulders and ditches grass will soon take their place. Whenever a mile of new stone road is constructed the contractor should be required to place about 100 tons of 1½-inch stone (ordinarily referred to as No. 2 stone) and screenings at convenient places for maintenance and repairs. During the summer months stone chips only should be used for patching.

The rake is one of the most useful tools used in stone or gravel maintenance. Large patches of stone or gravel should not be spread over the whole road at one time, especially in dry weather. All repairs should be made before cold weather, so that the road will consolidate and go through the winter in good condition. The best time, however, to patch stone and gravel roads is in the spring of the year. The spring showers will aid the traffic in consolidating the materials.

Before applying new material, all projecting stones should be removed and the surface slightly roughened with a pick. In applying new material thick layers should be avoided. One stone deep is ordinarily thick enough, and no stone used for repair work should be larger than two inches in diameter, and the size should be smaller for patch-work.

Trap rock, granites and other hard rocks should be broken finer for repair work than limestones and other softer rocks. Never crack stones on a road if you desire to secure a smooth surface. A thin layer of screenings, preferably trap rock, applied to a gravel road will produce a wearing surface almost equivalent to macadam.

Newly laid stone for patch-work or repairs should be bonded with screenings or a good quality of gravel. An excess of binder, however, should be avoided. In cutting away the worn out material for gravel and stone road shoulders all road scrapings, horse droppings and other rubbish should be kept off the road. Such materials will ruin the best road ever constructed.

The caretaker should never neglect an opportunity to remove loose stones from the road surface. Loose stones or water-worn pebbles should not be used for repairs or maintenance, as they will not bind.

Earth should not be used for patching stone or gravel roads, for earth turns to dust and after the first rain dust turns to mud. A mud blanket over the road will prevent it from drying out and hasten its destruction. The middle of the road should always be a little higher than the sides so that it will shed water quickly. This crowning, however, should not be carried to such an extreme that vehicles are forced to use the centre of the road only, thus confining the wear to two wheel tracks.

If the road is so badly worn or rutted as to require re-building the best practice is to roughen the surface with a scarifier drawn by a roller, or by means of spikes placed in the driving wheels of the roller. The surface is then harrowed and all large stones removed. After bringing the surface to the proper crown and cross-section a layer of No. 2 stone is applied, bonded with screenings, sprinkled and rolled in the same manner as for the original construction.

LOCATING LEAKS IN WATER MAINS BY MEANS OF THE WATER HAMMER DIAGRAM.*

By Melvin L. Enger,
Assistant Professor of Applied Mechanics, University of Illinois

WHEN the valve at the end of a long pipe line is closed suddenly, great pressures may be caused. The term water hammer has been applied to this phenomenon. If the valve could be closed instantly all of the water in the pipe would not be stopped at the same instant. The layer nearest the valve would stop first, then the next layer and so on until the impulse has travelled through the entire pipe line. As each layer of water is brought to rest its pressure will, of course, be increased. The velocity of the transmission of the pressure wave will be the same as the velocity of transmission of sound in the water in the pipe, and will vary between 3,400 and 4,700 ft. per sec., depending upon the material of the pipe and upon the ratio of the thickness to the diameter of the pipe.

It has been found that for any given pipe, the amount of the water hammer pressure is a constant times the extinguished velocity. The value of this constant (also called the water hammer coefficient) varies directly with the velocity of transmission of the pressure wave, and for cast-iron pipe used for water supplies has values between 45 and 63. For cast-iron pipe between 6 and 16 inches in diameter, the average value of the constant is about 55. That is, the water hammer pressure caused by the sudden closure of a valve at the end of a long pipe line, in pounds

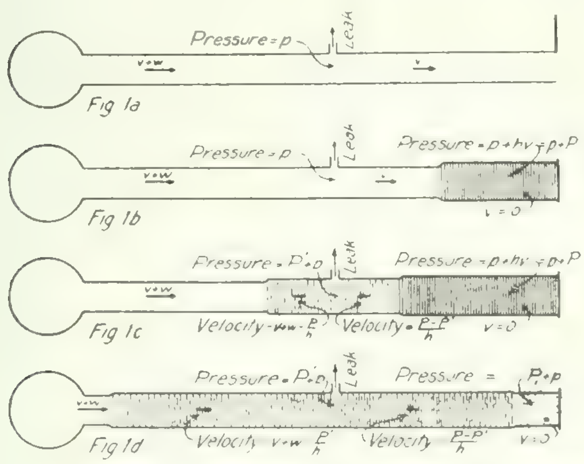


Fig. 1.—Condition of Pressure and Velocity at Various Times After Closing the Valve.

per square inch, is 55 times the velocity of the water in the pipe before the valve was closed, in feet per second.

Fig. 1a represents a pipe line in which there is a leak. The flow between the source (reservoir or large pipe) and the leak is $v - w$ feet per second, and between the leak and the valve is v feet per second. Fig. 1b shows the conditions in the pipe line a short time after the valve at the end is suddenly closed. The velocity of the water near the valve has been extinguished and its pressure increased hv lb. per sq. in. (h being the water hammer coefficient). If the distance from the valve to the leak is l feet and the velocity of propagation of the pressure wave is Z ft. per sec., the pressure wave will reach the leak l/Z seconds after the valve closed. Since the original pressure at the leak allowed a quantity of water equal to Aw cu. ft. per sec. to escape, it is evident that a higher pressure will cause a greater quantity to flow. The extinguished velocity between the leak and the source will, therefore, be less than v ft. per sec. Hence the water hammer pressure generated in this part of the pipe line will be less than hv lb. per sq. in. A wave of reduced pressure will therefore travel from the leak toward the valve. Fig. 1c shows the conditions a short time after the pressure wave has passed the leak. The wave of reduced pressure will reach the valve $2l/Z$ seconds after the valve closed. Fig. 1d shows the conditions a short time after the wave of reduced pressure has reached the valve.

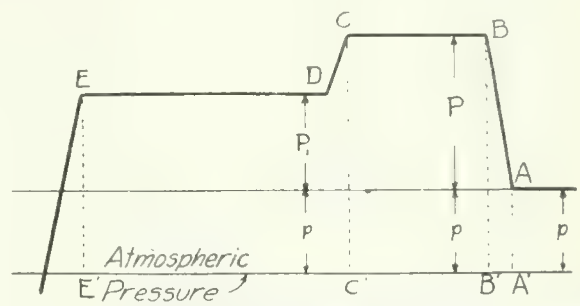


Fig. 2.—Typical Water Hammer Diagram Showing Effect of a Leak.

The water hammer diagram is a graphical representation of the pressure in the pipe line near the valve for a time after the valve is closed. In the experiments made by the writer the diagram is obtained by having the pencil of an indicator trace on a sheet of paper wrapped around a drum driven at a uniform rate by an electric motor. Another pencil attached to an electro-magnet makes a time record.

Fig. 2 shows the characteristic features of a water hammer diagram taken at the end of a pipe line in which there is a leak. The first rise of pressure as the valve begins to close is shown at A. The indicator pencil reaches B when the valve is fully closed. The pressure then remains practically constant until the effect of the leak is registered at C. The distance A'C' represents the time required for the pressure wave to travel from the valve to the leak and back to the valve. If the velocity of transmission of the pressure wave is known, the distance from the valve to the leak is easily computed. The difficulty in the use of this method is in the determination of the velocity of transmission (Z) of the pressure valve. The velocity of the pressure wave will vary somewhat, according to the amount of air in the water. Another method which avoids the necessity of determining the value of Z is as follows: When the indicator pencil reaches E, the first relief of pressure due to the source is felt. The distance A'E', therefore, represents the time required for the pressure wave to travel from the valve to the source and back to the valve. If the length of the pipe line from the valve to the source is L, the distance from the valve to the leak can be determined by proportion.

$$l : L :: A'C' : A'E'$$

In the writer's experiments, much more consistent results were obtained by this method than by the use of the velocity of transmission of the pressure wave and the time required for the pressure wave to go from the valve to the leak and return, as scaled from the diagram.

The quantity of water discharged from the leak can also be determined from the water hammer diagram. The

*From paper read before the Illinois Water Supply Association, March, 1914.

expression for the velocity of flow in the pipe due to the leak is:

$$v = \frac{\dfrac{P - P_1}{h}}{\left[\dfrac{P + P_1}{2p} - 1\right]^{0.5} - 1}$$

P is the amount that the pressure is increased due to water hammer, P_1 is the amount that the pressure at the valve is above the original pressure after the return wave from the leak reaches the valve; p is the original pressure at the valve; h is the water hammer coefficient.

The following values are taken from experiments made by the writer in 1906. The last two were measured from the second diagram shown in Fig. 4.

Calculated Distance. Feet.	Actual Distance. Feet.
64	72
70	72
371	381
385	381
375	381
262	265
295	265
110	113

A number of values have been computed from the equation, and the results have been plotted in Fig. 3. It was assumed that $P = 55$ lb. per sq. in., $p = 40$ lb. per

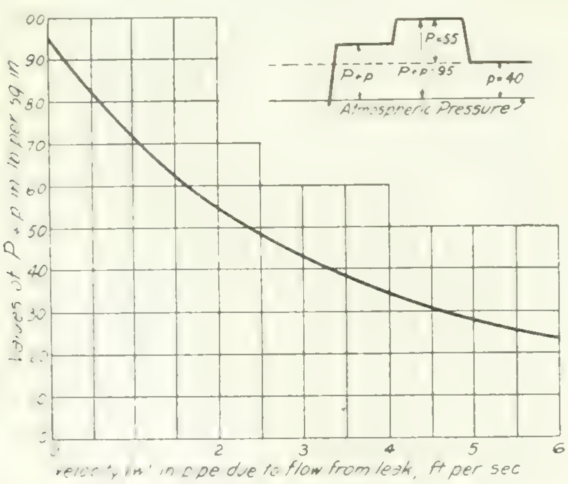


Fig. 3.—Pressure Drop on Water Hammer Diagram Due to Leaks of Various Amounts.

sq. in., and that $h = 55$. It will be seen from an examination of the curve that even small leaks will produce a noticeable fall of pressure on the water hammer diagram.

The first suggestion that the water hammer diagram could be used to determine the location of a leak was made by Professor Joukovsky as the result of a series of experiments made in 1897 and 1898 for the waterworks department of Moscow, Russia. He published a monograph (Stoss in Wasserleitungsrohren) in 1900. A translation of this paper, somewhat modified, was published in the Proceedings of the American Waterworks Association in 1904. Experiments were made by the writer in 1906 on a 2-inch pipe 730 feet long in the Hydraulic Laboratory of the University of Illinois. Fig. 4 shows two diagrams taken at that time.

In using this method for determining the location of a leak, the following suggestions are made. The quick-closing valve should be at the end of the section of pipe to be tested. This can be accomplished by tapping the main close to a valve, the valve in the main being kept closed during the experiments. The pipe leading from the main to the quick-closing valve must be large enough that a water hammer pressure at least as great as the static pressure can be caused by the sudden closure of the valve. The indicator should also be connected at this point of the main, or to the pipe containing the quick-closing valve. If possible, the method of proportional distances should be used. The distance to the source

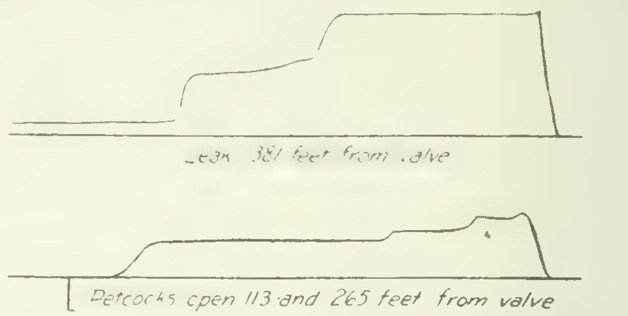


Fig. 4.—Water Hammer Diagram, Showing Effect of Leaks, Taken on a 2-in. Pipe Line, 730 Feet Long.

(large main) should be measured. A hydrant partly open will make a good reference point in case the main on which the experiments are being made is very long. When the method of proportional distances is used it is not necessary to know the speed of the paper. It is only necessary that the paper travel at a uniform speed while the diagram is being taken.

An apparatus called the "pulsograph," using the above principles for locating leaks, has been patented. It was described before the meeting of the New England Waterworks Association in September, 1913.

CONCRETE MATERIALS.

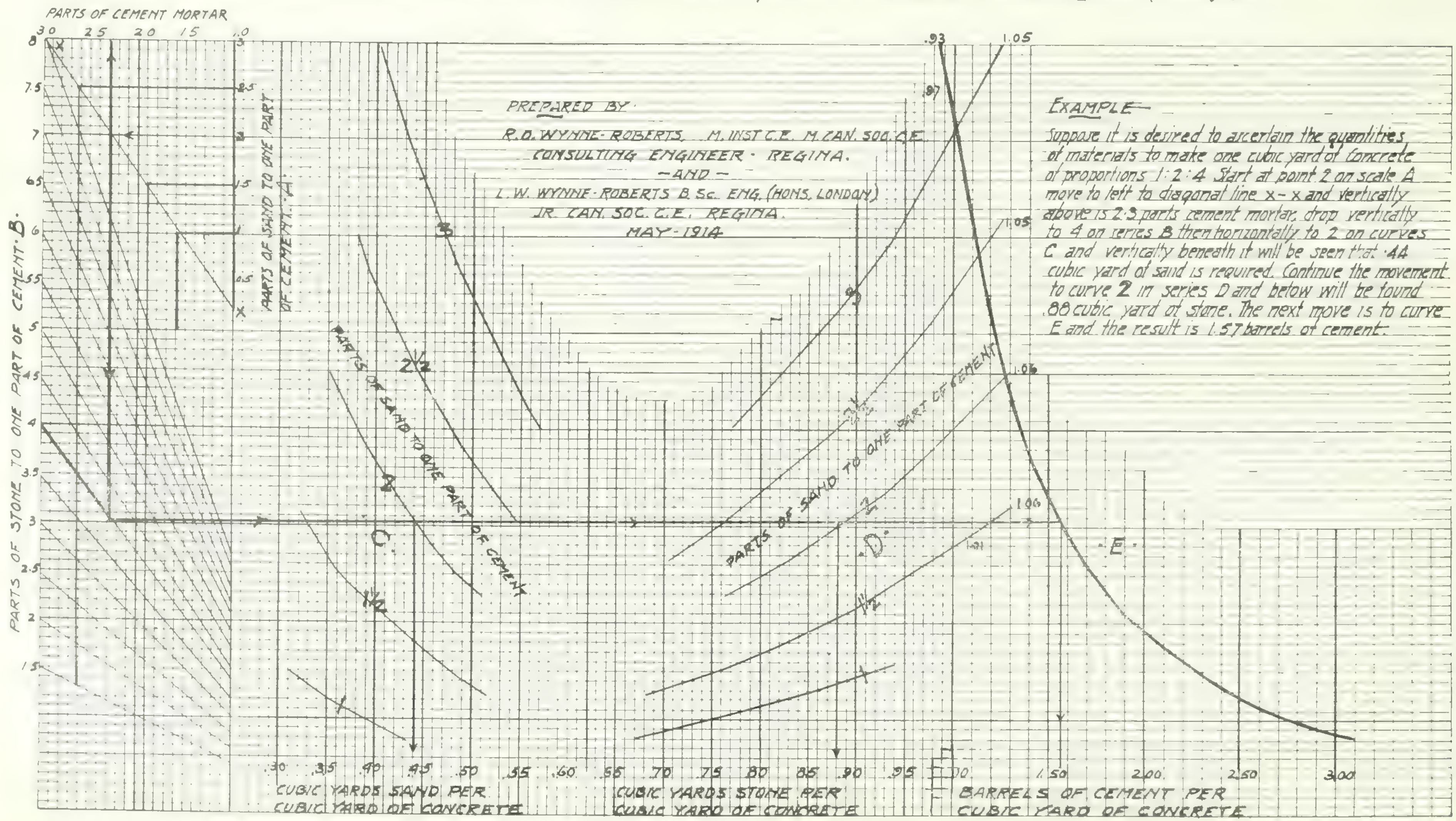
By R. O. Wynne-Roberts, Regina.

THOSE who have frequent occasion to prepare the estimated cost of concrete structures find it useful to have data as to the quantities of materials that are required to make one cubic yard of concrete of different proportions. There are tables given by various authors which are convenient for office use, but volumes are seldom carried about and consequently calculations, even approximate, are usually deferred until the engineer returns to his office. The author has experienced a need for a diagram which will afford the information as to the quantities of cement, sand and stone necessary per cubic yard of concrete in place and set to build one. The accompanying diagram is believed to be very simple and easily understood, and is applicable for concretes whose proportions range from 1:1:1½ to 1:3:8, which will doubtless suffice for practically all classes of work. The curves are derived mostly from tables in Taylor and Thompson's book on concrete and therefore no claim is made for originality of data, but the diagram is original. It is hoped it will be found useful by readers of *The Canadian Engineer*. In the top left-hand corner is given the volume of cement mortar produced by mixing various proportions of cement and sand. When any proportions of

cement, sand and stone are specified all that is necessary is to start on scale A with the given number for sand, trace that line to the left as far as the diagonal line X—X, then move vertically downward until the line crosses the sloping line giving the number for stone, and afterwards move to the right, intersecting the given sand volumes in series C and D and also the curve E, and vertically beneath each intersection will be found the quantities of sand, stone and cement respectively. An example is given in the diagram to show how the quantities of concrete ingredients for a proportion of 1:2:4 are found.

DIAGRAM FOR OBTAINING QUANTITIES OF MATERIALS REQUIRED PER CUBIC YARD OF CONCRETE.

Based on Barrel of Cement of 3.8 Cubic feet, and 45 per cent voids in broken stone and gravel. (average)



Coast to Coast

Oak Bay, B.C.—A lifting plant for sewage is being installed at Oak Bay, B.C.

Weston, Ont.—The sewerage system and sewage disposal plant at Weston have been formally opened.

Fort William, Ont.—Work on the constructing of the belt line route for the street railway at Fort William is in progress.

Winnipeg, Man.—It has been reported that the Manitoba Government elevator system has been acquired by United States interests.

Port Arthur, Ont.—The Port Arthur council has passed a by-law placing the money required in 1914 for general purposes at $300,210.40.

Saskatoon, Sask.—Money by-laws for the raising of $271,512 were passed at Saskatoon, being principally for additions to sewer and water systems.

Oxbow, Sask.—The municipality of Oxbow is considering and examining into the matter of installing an electric lighting plant for the town.

Edmonton, Alta.—All the by-laws which were voted on by the burgesses on April 6th have been given their third reading and finally passed by council.

Hamilton, Ont.—The proposal to construct a temporary sewage system in the eastern section of Hamilton has been dropped by the works committee of the city council.

Regina, Sask.—The Dominion Government has created a Saskatchewan headquarters for its electricity inspection branch of the Department of Inland Revenue at Regina.

Toronto, Ont.—The ratepayers of North Toronto have endorsed the proposed sewerage scheme for North Toronto as outlined by the engineers of the civic works department.

Winnipeg, Man.—To accommodate non-resident contractors, the board of control of Winnipeg has arranged to extend the time limits for receiving tenders for various kinds of work.

Saskatoon, Sask.—The city council has decided to resubmit the by-laws which were defeated at the polls. The most important one provides for $200,000 for power house extensions.

Ottawa, Ont.—Chairman Drayton of the railway commission has stated that he will take immediate steps to have the bridge on the York and Scarboro townline rebuilt without delay by the C.P.R.

Edmonton, Ont.—It has been reported that it is not unlikely that steps may be taken to establish a municipal paving plant at Edmonton. $35,000 is appropriated for this purpose, and it has never been used.

New Toronto, Ont.—A proposal for installing a waterworks system at New Toronto is under consideration by the municipality. It is proposed to take water from the lake, and also to construct a mechanical filtration plant.

Weyburn, Sask.—Money by-laws, amounting to $155,500, have been endorsed by the ratepayers, and work will proceed at once on the improvements concerned, which consist of extensions to sewers, waterworks and electric plant.

Carlyle, Sask.—Construction on the large municipal electric lighting system has commenced and will be carried to completion without undue delay. Messrs. Smith Electric Company, of Melville, have the work of installation in hand.

Toronto, Ont.—The total amount of revenue collected by the civic waterworks department for the term just ended, has been announced as approximating $450,000, or $50,000 more than was received during the corresponding period last year.

Port Arthur, Ont.—The agricultural and good roads committees of the Port Arthur board of trade have received information to the effect that $150,000 will be expended by the government on the roads of the surrounding district during the ensuing season.

Toronto, Ont.—The Ontario government has approved the 1914 programme of road and bridge construction for the County of York, and it is announced the work will commence immediately after the by-law authorizing expenditure has been altered to the extent of $300,000, instead of $100,000 as it now stands.

Redcliff, Alta.—The Redcliff Light and Power Company has commenced work preparatory to drilling the seventh gas well at Redcliff. It is located in the industrial section, and is expected to strike the gas at 1,200 feet. Gas is furnished to manufacturers at five cents per thousand, and power at $2.40 per h.p. per year in Redcliff.

St. Thomas, Ont.—Recently the value of the St. Thomas waterworks plant and system has been appraised by representatives of the Canadian Appraisal Company. The report submitted places the present value of the plant at $513,829, and the estimated cost for replacing the same at $577,992.32, thus allowing for a depreciation of $64,163.32.

Yorkton, Sask.—The Pas board of trade has written the Yorkton board of trade urging the endorsation of a resolution calling on the government of Canada to adopt means to compel railways now holding charters for branch lines connecting them with the Hudson Bay road to commence construction of the same under penalty of having said charters revoked.

Vancouver, B.C.—The civic board of works of Vancouver has adopted the list of new local improvement work amounting, with that already begun during 1914, to $1,400,935. The list as passed represents the limit of expenditure which the city may incur in this line at the present time. New work not yet formally approved by the board of works totals $104,972.

Victoria, B.C.—Messrs. Parks, Tupper, and Kirkpatrick, contracting firm for the government work at Soughees Reserve, has commenced work and expects to complete the contract by the end of June or early in July. The contract calls for the erection of a creosoted pile wharf, over 600 feet in length and 50 feet in width, and for the excavation and levelling off of approximately 27,000 cubic yards of material.

Calgary, Alta.—It has been announced by Dr. Ings, managing director of the Elbow River Power and Development Company, that the company will commence this fall the building of an electric railway which is to connect Calgary with Springbank and Jumping Pond. The line will be about 40 miles long, and will not take more than 5 or 6 months to construct. It will be known as the Elbow Suburban Railway.

Quebec, Que.—New plans have been deposited by the G.T.P. Railway company in the Quebec registry office which provide for a change in the site of the tunnel proposed to be constructed under the rock of Quebec. It will have an entrance in the vicinity of where the Dufferin Terrace passenger elevator is situated and will extend under the city and under the Laval University, with an exit at the foot of Damboruges street.

Winnipeg, Man.—The following summary of total expenditure on Winnipeg hydro-electric system up to the end of February, 1914, has been published: water power construction, $3,414,175.99; distribution system, $2,357,936.96; H. E. S. extension, $130,761.81; conduit system, $321,102.08; discount and express on sale stock and debentures, $174,495.52; water power and joint use of poles, $13,161.09; total expenditure, $6,628,068.97.

Fort William, Ont.—The commencement of construction on the 2,646-foot sea wall at the mouth of the Mission river is well under way. All of the timber for the cribwork has arrived from British Columbia and no interruption is anticipated until the contract has been completed. Three cribs, each 120 feet long, are in the water ready to be placed in position as soon as dredging has been completed to the depth required for sinking the cribs.

Victoria, B.C.—An agitation is on foot at Victoria to hasten the bridging of Seymour Narrows. It is planned that a special committee will take in hand the forwarding of the project, and that the committee shall send a delegation to Ottawa at the earliest possible date to urge the importance of the commencement of the work; also that all the various municipalities and associations interested be asked to send delegates to Ottawa with the Victoria delegation.

Leaside, Ont.—Construction is commencing at Leaside upon the factory building for the Canada Wire and Cable Company, to be erected at a cost of about $1,000,000. It is said that the structure will be one of the longest factory buildings in the Dominion. One section will be 500 feet in length and 3 stories in height, while the rest of the building will be one story. Already the most of the brick foundation has been laid, and a compressed air plant is being installed, so that the steel construction may be undertaken.

Medicine Hat, Alta.—The city engineer's report for the month of April shows that at Medicine Hat the high-pressure mains of the natural gas system were extended 1,500 feet; the water distribution system was prolonged by 3,863 feet of 6-inch pipe; 2 miles of domestic and storm sewers were laid; 3 miles of 6-foot cement sidewalk, 2,250 square feet of street crossings and 432 square feet of lane crossings were constructed; and in the electric light department about 2 miles of lines were erected.

Ottawa, Ont.—It has been reported at Ottawa that a movement is being made by the Hon. Robert Rogers to provide for an increase in the Government subsidy allotted to the construction of drydocks. This action is being taken so as to encourage these constructions to be of the first class. The present act provides for a subsidy of 3½ per cent. per annum of the cost of the drydocks for 35 years, where the expenditure is over $1,000,000. The Government now proposes to increase the subsidy to 4 per cent. per annum.

London, Ont.—London has already embarked upon pavement construction work for 1914 which will entail an expenditure of $100,000. Work on contracts amounting to $25,000 is now in progress, and tenders have been called for the Wortley road pavement, to cost $35,000. Pavements costing $40,000 in all will be laid during the summer on various other streets and roads of the city. Asphalt pavements with concrete bases will be laid in the majority of cases, although vitrified brick and other pavements will be tried in various sections.

Sault Ste. Marie, Ont.—The International Joint Commission has approved the joint applications of the Michigan Northern Power Company of Sault Ste. Marie, Mich., and the Algoma Steel Corporation of Sault Ste. Marie, Ont., to erect compensating works at a point in the St. Mary's River between the two cities. The approval has been given upon certain conditions, with respect to the construction of the works which have been recommended by the Government engineers of the U.S. and Canada, and also upon conditions governing the works after construction.

Moose Jaw, Sask.—By-laws are being advertised at Moose Jaw to provide for the raising of $12,985 for the extension of the city's waterworks through River Park and Wellesley Park; to provide $35,000 for construction of cement sidewalks with curb and gutter; $12,000 required to complete street paving; $106,761.78 for extension of sanitary sewers through various portions of the city; $155,000 for extensions to the electric light and power system; $17,015 for the extension of sanitary sewers in River Park and Wellesley Park; $18,700 to pay the deficiency of moneys on civic works previously undertaken; and for $73,238.22 for extensions to the civic waterworks system.

Amherst, N.S.—A great deal of bridge work is contained in the program of construction to be carried out this year on the Intercolonial Railway. 105 light steel bridges will be strengthened so as to accommodate heavy power from Truro to River du Loup, and already contracts for 40 have been awarded to various bridge contracting companies in Canada. The Rhodes, Curry Company, of Amherst, N.S., have secured contracts from the Dominion Government for 9 girder bridges; and the steel that will be used is to be imported in channels and fabricated at the shops of the Canadian Car and Foundry Company, of Amherst.

Montreal, Que.—The surplus earnings of the Montreal Light, Heat, and Power Company, or earnings available for dividend purposes, for the year ended April 30th, will be over $3,000,000, or what will mean a rate of close upon 18 per cent. The percentage of the previous year was 15.9. An idea of the growth of the company is afforded by a reference to the company's record. Gross earnings before operating and maintenance expenses and fixed charges were below the $3,000,000 mark in 1904. The company is now earning more for dividends than it took in in gross receipts nine years ago. This has been accomplished in the face of a steady reduction in both electric and gas charges to its consumers.

Ottawa, Ont.—It is reported that there will be an overdraft amounting to several thousands of dollars this year in the Ottawa city waterworks department. The appropriation for the department for the year is $153,000. In January the expenditure was $35,860; February, $12,006; March, $16,606; April, $12,504; the total amount spent to the end of last month being $76,979. The total expenditure up to end of April last year was $63,536. The increase is due to the fact that this year the waterworks department has a number of additional expenditures, including the maintenance of the booster plant and the wells, and the cost of the new intake pipe. However, the department hopes to keep the expenditure for the twelve months within $155,000.

Ottawa, Ont.—According to the statement of Sir Donald Mann, recently published at Ottawa, the C.N.R. line now under construction from Ottawa to Port Arthur, via Pembroke, Eastport, North Bay and Sudbury, will be put in operation for freight and local traffic some time next fall. With the completion of this line from Ottawa to Port Arthur the C.N.R. will have a through line in operation from Quebec to British Columbia, passing through Montreal, Ottawa, Pembroke, North Bay, Sudbury, Winnipeg and most of the large and important centres in the West. Ottawa will be the junction point on this transcontinental line for the line to Toronto and on through Parry Sound, joining the main line again at Capreol, a comparatively short distance west of Sudbury.

Montreal, Que.—Active work is now in progress on the general plan of improvements along the Montreal harbor front. The main works so far are at the Victoria pier, where the old wooden pier has been removed and the site is being dredged out to make place for a modern concrete jetty, while there will also be put in a new pier 1,800 feet long. Similar work is being done at Section 27, where the old wooden pier is being replaced by a concrete jetty. Work is also being done filling in the space between the Canadian Vickers Company's drydock and the shore. All the gas and spar buoys, as well as the lightships, have been placed in Lake St. Louis. [illegible]

lights and aids to navigation on the Lachine Canal and Lake St. Louis had been completed.

Victoria, B.C.—The work of laying a 12-inch main to connect the Gorge Road main with the temporary pipe line over the Gorge, through which the city is now securing its supply from the system of the Esquimalt Waterworks Company, has been completed. The new main will provide for an additional supply approximating 1,000,000 gallons per day and bring the total supply available from the Esquimalt Waterworks Company to slightly below 6,000,000 gallons per diem. By next fall the pipe line of the Sooke system will be laid from the city to a point beyond Parson's Bridge. When this is done a permanent connection with the system of the Esquimalt Waterworks Company will be made at the bridge, and at any future time, if accident should interfere with the Sooke supply, instant connection with the company's system will be possible.

Halifax, N.S.—Mr. Thomas Cozzolino, president of the Nova Scotia Construction Company, Limited, stated recently in connection with the work being done by his company on the Dominion Atlantic section of the C.P.R., that in constructing No. 2 pier at the north end of the Halifax harbor 1,600 concrete piles had been sunk, each from 58 to 78 feet in length and weighing as much as 75 tons. These were driven into the bottom of the harbor, where the water is from 38 to 40 feet deep by a hammer weighing about 16 tons. About 300 more of these piles will be driven, making a total of about 2,000. Mr. Cozzolino state that experts aver that this piece of work has formed the solution of the concrete pier problem. The wharf will be 800 feet in length, and will cost, when completed in August, about $1,000,000. Concrete sheds of the finest construction are also called for in the plans for the work being carried out at this port.

Winnipeg, Man.—W. E. Skinner, consulting engineer, recently gave an interesting talk on the hydro-electrical resources of Manitoba at a union of the Jovian order at Winnipeg. He stated that, according to the report made to the government on water-powers within the province, the total amount of power within the limits of the province that can possibly be developed was 3,037,355 horse-power; and in the summer months, from May to October, there would be available another 218,430 horse-power. This, Mr. Skinner pointed out, was three times as much power as was used in the cities of Chicago and New York for all purposes during last year. While much of the power in Manitoba was at present inaccessible, the resources of the country would bring it close to hand.

Fort William, Ont.—Work will soon be commenced by the Thunder Bay Contracting Company on the 2,646-foot sea wall which is to be built at the mouth of the Mission river. The first work to be done to the wall was commenced early last March, but only timber enough for the construction of three cribs was on hand; and when this was used, work was stopped until a fresh supply could be obtained from the lumber mills in British Columbia. This supply is expected to arrive this week. The wall will be built on the crib construction plan from the bottom of the river, which is 28 feet deep at that point, to the surface; and from there up the wall will be constructed of concrete. When completed, it will be the means of reclaiming several acres of valuable land from Lake Superior.

Toronto, Ont.—The Department of Colonization Roads of the Ontario government has already commenced sending road gangs throughout Northern Ontario, since this season's program of work is a considerably extensive one. A highway connecting the Transcontinental and Canadian Pacific Railways through Waubagoon township will be undertaken at once. Other roads to be constructed are a new trunk road running out of Sudbury and Conaston, one connecting Quibell and Vermillion, and the Gowganda road in the pulpwood district of Espanola. Further, the Provincial and Dominion governments have under present consideration the extension of the trunk line of roadway running between North Bay and the Soo, so as to make through connection between Ottawa and Sault Ste. Marie. The contemplated new section of this highway would follow the old military road from Ottawa to Mattawa, and thence to North Bay. The extension is being strongly urged, and it is likely that the proposal will be adopted.

Toronto, Ont.—It has been announced that early in June will commence a motor survey of Ontario to be made under the direction of the provincial highways department, the purpose of which is to furnish the basis for construction work next year upon the $30,000,000 highways system for older Ontario. The motor survey will be carried on by several corps of engineers, each with a section of the province to cover. They will determine the present condition of all the travelled roads, urban, interurban and rural. They will study local conditions with a view to finding out which should be improved and the type of construction best adapted to meet traffic requirements. Sources of road-building material will also be investigated. Upon the completion of the survey tentative schemes will be submitted to the various counties and townships with a view to arriving at permanent plans. At present, the department has engaged 12 draughtsmen on the preparation of county and township road plans, upon which the progress of construction on each type of highways will be recorded from season to season.

ZINC AND POWER POSSIBILITIES AT NELSON, BRITISH COLUMBIA.

An outcome of the efforts which have been made by the board of trade of Nelson, B.C., and of mining men of the district, to induce the Woolsey, McAlpine, Johnson Zinc Corporation of New York to locate its proposed new electric zinc smelting plant at Nelson, has been to awaken interest in the possibilities of the district. Consequently, Mr. Johnson, Dr. Struthers, his associate, and Dr. E. A. Barlow, of McGill University, Montreal, who has been working on the problem for the Canadian Federal Government, are now at Nelson going into the question of electric power supply, site and other questions.

It was on account of the success which has been achieved by the Johnson process that the Government, on the advice of W. R. Ingalls, of New York, zinc expert, discontinued its work and decided to await further results from Mr. Johnson.

Huge bodies of low-grade zinc ore, in developed and undeveloped mines of the district, await the solution of the treatment of complex zinc ores and if the process is carried to a complete success it will mean a heavy increase in mining operations in this district.

With last week's output the total production of mines in Rossland, Slocan-Ainsworth, Nelson and East Kootenay districts this year was brought to 182,837 tons. Shipments to Trail smelter last week totalled 7,030 tons, which is 804 tons greater than those of the previous week. Shipments to the smelter for the year are 117,053 tons.

The Granby Con. Co., of Anyox, B.C., is operating only one of its blast furnaces at its new works at which smelting was commenced on March 16. It is stated that experience thus far indicates that ore from the company's Hidden Creek mines, near here, can be smelted without lime flux, and that 700 tons a day is being put through the single furnace in blast.

AMERICAN WATERWORKS ASSOCIATION.

The 34th annual convention of the American Waterworks Association was held last week in Philadelphia, and was exceedingly well attended. One noteworthy feature of the meeting was the early arrival and registration of delegates, over 600 having registered before the end of the second day of the convention.

Monday was taken up largely with administrative matters. Several recommended amendments were discussed. These were adopted at the Tuesday morning session, which also included the report of the executive committee and the address of welcome of Mayor Blankenburg, and the President's annual address.

The election of officers resulted in the election as president for 1914-15, of George G. Earl, General Superintendent of the Sewerage and Water Board of New Orleans; vice-president, Nicholas S. Hill, Jr., Consulting Engineer, New York; treasurer, James M. Caird, Troy, N.Y., and trustees, Allen Hazen, Consulting Engineer, New York, and H. W. Cuddeback, Superintendent Passaic Water Company, Paterson, N.J.

The following were among the Canadian delegates present at the convention: W. H. Randall, Toronto, Ont.; Thos. Hodkinson, London, Ont.; H. Hymmen, Berlin, Ont.; Geo. K. Crocker, St. Thomas, Ont.; F. A. Dallyn, Toronto, Ont.; J. J. Salmond, Toronto, Ont.; J. D. Barnet, Stratford, Ont.; A. Milne, St. Catharines, Ont.; T. F. Matthews, Peterborough, Ont.

COMING MEETINGS.

INTERNATIONAL CONFERENCE ON CITY PLANNING.—To be held in Toronto, May 25th, 26th and 27th, 1914, in charge of the Commission of Conservation. Secretary, James White, Ottawa.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

PERSONALS.

CHAS. F. LAW, of Vancouver, is in charge of location work for the proposed Pacific, Peace River and Athabaska Railway.

D. W. HOUSTON has been appointed superintendent of the Regina Street Railway. Since the resignation of H. Doughty he has been acting superintendent.

W. C. BRENNAN, of Hamilton, has been appointed street commissioner for the city of Fort William, Ont. Mr. Brennan was at one time street commissioner of Hamilton, Ont.

WILFRED P. BRERETON, B.A.Sc., '03, of the University of Toronto, who was formerly connected with the Power Construction Department of the city of Winnipeg, and who has also been connected with much engineering work in Toronto and Hamilton, was appointed, on May 19, city engineer of Winnipeg.

PAUL E. MERCIER, B.A.Sc., Am. Can. Soc. C.E., of Baulme and Mercier, consulting engineers, Montreal, was recently appointed assistant engineer to the city of Montreal. Mr. Mercier, who was formerly resident engineer at Quebec for the Department of Public Works, and also a constructional engineer for the Transcontinental Railway, will assume his new duties in a few days.

OSCAR B. MUELLER, president and general manager of the H. Mueller Manufacturing Company, Limited, of

Sarnia, Ont., was elected president of the American Waterworks Manufacturers' Association.

M. P. BLAIR, city engineer of St. Boniface, Man., and C. L. HUFF, town engineer of Athabasca, Alta., have been transferred from associate members to members of the American Society of Civil Engineers. FRED. L. MACPHERSON, municipal engineer of Burnaby, B.C., A. R. MOORE, resident engineer, Kettle Valley Railway, Kelowna, B.C., and W. W. SMITH, assistant engineer, Grand Trunk Railway, Montreal, have been elected associate members.

OBITUARY.

The death occurred last week of William Wainwright, Sr., vice-president of the G.T.R. and G.T.P. Mr. Wainwright had attained the age of 74 years. At the age of 18 he began his railway career. He came to Canada at the age of 22 as senior clerk to the chief accountant of the G.T.R. at Montreal. Since that time he has been constantly associated with the company.

Notice has been received of the death in Paris of P. L. T. Heroult, whose prominence as a scientist and whose research work in the commercial production of aluminium and in the development of the electric furnace is so well known. M. Heroult was 58 years old.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21778—May 7—Directing that crossing of Berlin and Northern Ry. by G.T.R. on Wellington St., Berlin, Ont., be protected by half-interlocking plant, derails on G.T.R. 100 ft. from diamond, semaphores on Berlin and Northern 100 ft. from diamond; derails and semaphores be interlocked and operated by conductors of Berlin and Northern Ry.; position of signals be "clear" for G.T.R. and "danger" for Berlin and Northern Ry. G.T.R. bear and pay whole cost of providing, maintaining and operating interlocking plant.

21779—May 7—Directing C.P.R. construct highway crossing at Pine St. Sault Ste. Marie, Ont., cost of constructing and maintaining crossing and changing grades be paid by Railway Company.

21780—May 7—Directing that crossing of G.T.R. by Berlin and Northern Ry. at Bridgeport St., Berlin, be protected by half-interlocker, derails on Berlin and Northern 100 ft. from diamond, semaphores on G.T.R. 300 ft. from diamond; derails and semaphores be interlocked and operated by conductors of Berlin and Northern. Position of signals be "clear" for G.T.R. and "danger" for Berlin and Northern. Berlin and Northern bear and pay whole cost of providing, maintaining and operating half-interlocking plant.

21781—May 7—Reducing joint commodity rates of Chatham, Wallaceburg and Lake Erie Ry. and P.M.RR. in connection with G.T.R. and C.P.R. for carriage of sugar, in carloads, from Wallaceburg, Ont. to Hamilton and Toronto, to 10½c. per 100 lbs. and 11½c. per 100 lbs. respectively, on minimum of 40,000 lbs. per carload; said reduced rates be effective not later than May 25, 1914.

21782—May 6—Authorizing C.P.R. to construct spur for Francis Hankin and Co. and Canada Sand and Concrete Co. from end of existing spur at mileage 7.81, St. Gabrier Subdivision, Lots 175, 176, Les Prairies Range, parish St. Charles Borromee, Que.

21783—May 7—Extending, until July 1st, 1914, time within which G.T.R. submit for approval plan showing location of new station at Summerstown Station, Ont.; work to be completed by November 1st, 1914. And directing that Ry. Co. forthwith remove telegraph poles shown in photographic views No. 1 and No. 3, under File No. 23646; and provide 4-wheel truck to carry milk and cream to movable platform on south side of present platform.

21784—May 8—Amending Order No. 21728, April 29th, 1914, by adding words "over the tracks of the G.T. and C.P.R. Cos." after word "crossing," in 2nd line of operative part of Order, and adding words "and an engineer of the C.P.R. Co." after word "Company" in last line of operative part of Order.

21785—May 8—Authorizing C.P.R. to operate trains over portion of Weyburn-Westerly Branch Line from Woodrow, mileage 145.7 to Shaunavon, mileage 230.8, at speed not exceeding 25 miles an hour, instead of 18 and 10 miles an hour as provided in Order No. 21227.

21786—May 8—Disallowing tariffs and supplements applicable to international traffic filed by G.T.R., M.C.RR., Wabash RR., C.P.R. and P.M.RR.

21787—May 8—Authorizing G.T.R. to operate trains over 25 bridges on its 15th District.

21788—April [illegible]—Directing that C.N.R. construct a road north of its tracks, connecting road allowance between Secs. 5 and 8-18-21, W.P.M., with some street in Elphinstone, Man.; location of new road to be as nearly as may be on line A B on plan dated Winnipeg, 12 November, 1913; work to be completed by June 15th, 1914; 20 per cent. of cost of work herein directed be paid out of "The Ry. Grade Crossing Fund," remainder by Railway Company.

21789—May 1[illegible]—[illegible] with respect to lines of [illegible] C.P. and C.N.R. Cos. or either of them between Mon[illegible] and Ottawa, and between Montreal and Hull, including [illegible] Hawkesbury and Rockland branches [illegible] between Hull and Waltham, Hull and Maniwaki, and Ottawa and Pembroke, all termini inclusive, Order No. 21621, dated April 19th, 1914, by publishing and filing of tariffs by said Cos. under provisions of Subsection 2 of Sec. 328 of Ry. Act, to take effect not later than one week from issuance of this Order, to apply on lumber to Montreal, for export, reinstating rates charged during season 1913 from those stations whence "export" rate has been made same as "domestic" in tariffs suspended by Order No. 21621, which tariffs shall be superseded in so far as they conflict with this Order. Dismissing complaint against increased rates to Montreal for local delivery.

21790—May 11—Authorizing C.P.R. to use and operate bridge No. 133.28, Algoma Subdivision, and bridge No. 102.55, Algoma Subdivision, Lake Superior Division.

21791—May 12—Approving and authorizing clearance between C.P.R. standard coal sheds and rail of side tracks, subject to due performance of Co.'s undertaking to keep employees off sides of cars when operated over said tracks at Co.'s standard coal sheds; and rescinding Order No. 21446, dated March 5th, 1914.

21792—April 30—Amending Order No. 21281, dated February 7th, 1913, by striking out words and figures, "No. 55085-2, dated November 27th," after word "plan" in recital to Order, and substituting therefor words and figures, "No. 55085/3, dated Montreal, December 17th."

21793—May 13—Authorizing C.N.R. to construct across and divert two (2) highways, namely,—between Secs. 20 and 29-28-26, W. 2 M., and between Secs. 29 and 30-38-26, W. 2 M., near Dana, Saskatchewan.

21794—May 13—Authorizing C.N.O.R. to divert Symes Road, Lot 37, Con. 3, F. B., Tp. York, Co. York, Ont., and carry said road under railway by means of subway; clear head room of subway between 14 ft., and clear width 20 ft.; grade on north approach be changed to 5 per cent.

21795—May 12—Approving location C.P.R. station at Larchwood, Lot 11, Con. 3, Tp. Balfour, Dist. Sudbury, Ont., mileage 96.25 on Cartier Subdivision, Lake Superior Division, station to be in accordance with Co.'s Standard Structural Plan 5.

21796—May 13—Authorizing C.P.R. to construct road diversion in Sec. 1-15-14, W. 3 M., Sask.; and construct Swift Current South-easterly Branch Line across said diversion, mileage 4.78, Authority herein granted is without prejudice to right of Board of Highway Commissioners for Saskatchewan to apply to Board of Railway Commissioners, for Canada, at any future time, for separation of grades at said crossing.

21797—May 13—Authorizing C.P.R. to construct, at grade, tracks of through siding across Inches Ave and La Croix St., city of Chatham, Ont., at mileage 64.86, Windsor Subdivision.

21798—May 13—Authorizing C.P.R. to re-construct bridge No. 103.25 on Hamilton and Goderich Sub. Div., near Auburn Station, Ont.

21799—May 14—Extending, until Aug. 15th, 1914, time within which C.P.R. be required to construct and complete subway at Dundas St., city of Woodstock, Ontario.

21800—May 14—approving revised location of C.P.R. main line as constructed, and construction of additional track (double track) on said revision, from point in Lot 6, Rge. 7, Tp. Pic, Dist. Thunder Bay, Ont., mileage 51.49, Schreiber Sub. Div., Lake Superior Div., to point in Lot 11, Rge. 6, Tp. of Pic, Ont., mileage 54.37.

21801—May 14—Approving revised location C.P.R. as constructed, and of additional track (double track) on said revision from point in Tp. 86, Dist. Thunder Bay, Ont., mileage 10.00, Nipigon Sub. Div., Lake Superior Div., to point in Mining Location 85 Z, Tp. 86, Dist. Thunder Bay, at mileage [illegible], Nipigon Subdivision.

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The Canadian Engineer

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IMPORTANT PRINCIPLES OF BRIDGE DESIGN

SYNOPSIS OF PAPER BY CHARLES EVAN FOWLER, M.CAN.SOC.C.E., M.AM.SOC.C.E., BEFORE PACIFIC NORTHWEST SOCIETY OF ENGINEERS.

The designing of a bridge structure is not merely a matter of figuring the stresses, fixing the sizes of materials, and making a set of drawings. This may all be completed and a design result, but not the design suitable to the location, not such as it should be architecturally, nor for the traffic the structure will carry.

The true design to adopt must come very largely as an inspiration to the designer, who must have the necessary talent or imagination to conceive a bridge that will be the most appropriate and harmonious for a given location and for the existing or future surroundings.

The tower bridge in London, considered by many writers to be a monstrosity, was conceived by the engineer, Sir John Wolf-Barry, to harmonize with the surroundings, and particularly with the old Tower of London in the immediate vicinity. When considered in this light, it is an appropriate and harmonious design; the medieval towers are monumental and the steel work graceful.

The great suspension bridges of New York City are of the same class and are mostly in harmony with the towering buildings in the adjacent territory. The details, however, are not always carried out in the proper spirit, the towers of the Roebling bridge having never been completed and are thus lacking as truly monumental or architectural features; the towers of the nearby Manhattan bridge are too light to harmonize with those of the Roebling bridge or the nearby buildings, although considered alone it is a complete and pleasing design; the Williamsburg bridge is entirely lacking in architectural features, is out of harmony with the present or probable future surroundings, and is only notable in design by reason of its magnitude and the graceful sweep of its cables.

The great arch at Hell Gate, over East River in New York City, is with its 1,000-ft. span and carefully designed abutment towers a truly monumental structure, and the abutment towers are well designed and appropriate; the great arch demanding this mass for backing to properly satisfy the impression of a great thrust properly cared for or resisted.

The Washington bridge across the Harlem, one of the great bridges of the world, is wonderful in its architectural detail, but lacking in the great essentials for a work of architecture. The main structure consists of two spans instead of three, thus giving a pier in the middle; and the approaches are not balanced, thus causing the structure to lack in symmetry. Some of the other designs for this structure, while more simple in detail, would have made a much better structure and a more pleasing one, as they possessed the fundamental features that are necessary to any real work of architecture, simplicity, symmetry, harmony, and proportion.

This is well illustrated by the Eads bridge at St. Louis, with its three great arch spans and appropriate approaches, and although the details of the structure are very simple, it is one of the most pleasing and dignified of the world's bridges.

The conception of a design depends upon no rules, but upon the inherent ability of the designer, limited as we shall hereafter see by certain theoretical and practical requirements. There may be conceived a number of designs for a given location of different types, any one of which would be appropriate and beautiful, but the final decision as to which one of these to adopt must be made on the basis of relative cost, the most economical being usually selected. On the other hand, the most economical should not always be selected, but the best design architecturally be adopted, especially where the difference in cost is not very large.

The cost, for example, of a four-span structure for a given crossing might be found to be somewhat less than for a three-span bridge, and yet it would be wise from an architectural standpoint to adopt the three-span design, as the risk of one more foundation in the river would be avoided, with a probable saving in cost, should difficulties be encountered, that would make the three-span structure the cheaper in the end. In other words, the four-span design would have to be very much cheaper than three spans to call for its adoption. The reason for adopting a three-span design in place of a two-span bridge, might, on the other hand, be based entirely on the architectural features, as the cost and risk of the three-span structure might be much the greatest.

There are, then, two considerations that govern in making a decision as to what design to adopt for any location, the architectural features and the economy of construction, which latter may well be discussed in full before considering the architecture of bridges, and entirely aside from the esthetics of the problem.

The reactions or loads on piers for various lengths of spans must first be determined in order that foundations, abutments, and piers may be designed and the costs determined as factors in the cost of complete structures with different numbers of spans. The load on the pier and the weight of the pier having been determined, the size of the base of the pier may be arrived at by using the formula for the allowable pressure on the foundation bed, as given in the writer's treatise on "Sub-Aqueous Foundations," the character of the foundation bed having been determined previously by careful core borings. Several trials may be necessary before the proper size of a pier is de-

termined, and then careful calculations as to the stability of the pier must be made, and should it be found deficient, as is often the case with deep trusses, or where bascule or lift spans are employed, then it must be increased in length of base until the maximum allowable stresses and pressures are not exceeded.

Then by means of the cost of abutments, piers and spans, the relative costs of various designs may be determined; the weight of the spans to be calculated from reliable formulae or from actual stress and section diagrams. The design of the approaches may be a factor in the relative costs, and in such cases must be included in making the comparisons.

The fact that some consulting engineers make out certain designs to be the cheaper, when comparing them with other designs made up on an entirely different basis, both as to the character of the construction and the real factors of safety, should make any one suspicious of the character of the services offered and disbar such engineers from reputable practice.

The type and design of the superstructure is such a large factor in its cost that this must be fully decided upon before beginning any of the above investigations, and then all designs be compared upon a common basis. Where the grade is high above the stream, with plenty of clearance for floods and navigation, deck spans of some type are, of course, the most economical to employ. Where the bridge is high or falsework expensive for other reasons, it may be best and cheapest to use an arch or a cantilever design, and where very long spans are necessary, either the cantilever or suspension bridge must be used. Where the clearance for high water or navigation is limited, through trusses must be used, although it will often be best to use cantilever spans instead of simple trusses. Through arches or half-through arches may often be employed with good results both architecturally and economically.

The economical design of the superstructure of a bridge requires careful consideration as to the style of trussing, the panel length, and the truss depths. Longer panels and deeper trusses are more economical for modern heavy loads, but for plate and riveted lattice girders the depths are usually much less than for regular trusses. The span lengths for cantilever bridges should always be decided by careful mathematical analysis, as well as the lengths of the cantilever arms, suspended spans and depths. The height of towers and the depth of stiffening trusses for suspension bridges must also be carefully analyzed.

The design of movable spans should be carefully considered, not only with regard to first cost, but as to cost of operation and maintenance as well, but do not get the idea that revolving draw spans are out of date, for in many locations they are the cheapest and the best to employ. Then there are locations where bascule spans are the best from every point of view, but where used they should harmonize with the remainder of the structure if there are additional spans, but in any case those forms must be abandoned that have no pretentions to architecture or beauty, and the same thing may be said with regard to other types of movable spans.

The details for ordinary spans have reached a practically permanent basis, so that standards, at least as to type, are usual. Where the structure is of unusual size, like the Blackwell's Island bridge, the Forth bridge, or the Hell Gate arch, each member must be the subject of critical analysis and study.

Lack of such study and analysis was the cause of the failure of the first Quebec bridge, although the writer's one-time assistant, the late A. H. Heller, had fully covered the points in question in his book on "Stresses in Structures." Great suspension bridges, too, are of necessity special problems throughout and must be studied with greater care than any other type.

The floors of railway spans are usually of a standard type, either with steel stringers and ties or else a steel trough floor with ties laid on the ballast; but the types of floor and paving for highway bridges are so numerous that it is often a grave question what to adopt. The cheapest floor that should in any case be used on a good bridge is one having steel joists with spiking strips bolted to them, to which the floor plank is spiked. The very best floor is undoubtedly a reinforced concrete slab, with from 1½ to 2 in. of sheet asphalt surface, although it may be wise to use a creosoted block surface, the thin blocks being set directly in asphalt on the concrete and either filled with sand or grouted.

Having discussed those things which have to do directly with the economy of bridges, with masonry piers and steel superstructures, we may well discuss structures built entirely of stone or concrete, or of reinforced concrete. Such structures must be fully designed and a careful estimate of cost made in order to make any reliable comparisons. The cost of stone bridges is, of course, the greatest of any type that might be considered, and in the case of the Knoxville bridge, where the cost of the arched cantilever was only $250,000, the bid for the stone arch design was about $1,500,000, thus making it out of the question to use stone where low first cost was a necessity. The same is true to a very great degree with concrete arches, but when reinforced concrete arches are considered, they may be designed to cost but slightly more in many instances than steel bridges, and should be carefully considered where a permanent and artistic structure is demanded.

The writer has for many years made a study of the architecture of bridges, and his book of "Engineering Studies" was the first and only attempt that has been made to formulate any rules of architectural bridge design. It will be superfluous perhaps to say that the statement of an eminent engineer, in a recent report on a great bridge, that beauty could not be secured unless economy was sacrificed, does not meet with agreement from the writer.

There are, it is true, no orders of architecture for bridges as for buildings, nor is there any classification of styles for particular ages possible, as in the case of building architecture, but basic rules must be observed, whether the design be for a building or for a bridge.

Simplicity, harmony, symmetry, and proportion must be regarded in any design that would have any pretentions to beauty or to architectural effect. They are the fundamentals of true architecture, no matter what the structure may be to which thought is to be applied in its design.

Simplicity means first a truth-telling structure, no subterfuges about the lines of stress, no covering up of a concrete structure with a stone facing, no frivolous or inappropriate details, but a strict adherence to the necessary features, whether they are to carry the loads or to ornament the bridge.

Harmony is essential to a pleasing design, for without it the structure would be distasteful. Harmony not only as between substructure and superstructure, between the various spans, between the spans and the ap-

proaches, between the utilitarian features and the ornamental details, but with the surroundings.

Symmetry may or may not be essential to a pleasing design, although it usually is necessary if a truly architectural structure is to result. Where the bridge has a great length, unsymmetrical features are not so noticeable as in a shorter one which may be all taken in at a glance. As is often true in a landscape, balance may frequently be secured by including an unsymmetrical feature. That is, where in one portion of a structure such as a draw or other unbalanced feature must be included that will destroy the symmetry, something must be introduced in the other portion to restore the balance, although symmetry does not result.

Proportion is necessary that the three preceding principles may be realized, and usually when the economical proportions have been determined, they are pleasing. However, in many cases modifications must be made to reach the point where economy and beauty can both be satisfied. Proportion of details employed for ornamentation is quite another thing, and to be harmonious they must have the proper balance.

Examples may be seen in every structure of the proper application of some of these principles, but more often we find one or the other flagrantly violated, so that the remark of S. Shaler Smith to one of his assistants, should be well remembered by him who would reach high rank in his profession—"most bridges are examples of what not to do." Seldom, if ever, do we find a structure that complies with all of the fundamentals, although many bridges approach so nearly to the ideal that careful consideration and analysis are necessary to determine just where improvement could be effected.

Simplicity is best illustrated in its pleasantest features by suspension bridges and arches with no decorations or embellishments of any kind. Harmony is best exhibited where no part of the structure seems to be extraneous and where the structure seems part of the surroundings. Symmetry in its simplest form is where one-half of the structure is exactly like the other. Proportion is most nearly reached when the structure is most pleasing and the truth expressed most accurately.

The basis for a real architectural system for bridges must come, of course, from building architecture and on studying the columned or arched facades of buildings we find an uneven number of openings or arches are employed in the great majority of the world's notable and best pieces of architecture. Where there is an entrance it is nearly always in the centre, with one or more arches symmetrically disposed on either side.

Careful study and analysis of the examples of Egyptian, Roman, and medieval buildings discloses the fact that such an arrangement is most pleasing to the senses and where it has been violated the design is unpleasant. This, then, we may take as the starting point of any design, an opening instead of a pier at the centre, with the remainder of the structure arranged symmetrically on either side. Carried to its logical conclusion, where there is an approach it should have an uneven number of openings, and where there are spandrel arches employed in an arch bridge, they should be of an uneven number.

The Knoxville arched cantilever, designed by the writer, was of five main spans and two anchor arms, thus giving an opening at the centre and a perfectly symmetrical structure, except that one abutment was longer than the other, but not apparent to the eye in a structure a third of a mile long. Economy was violated in the depth of the anchor spans in order to make the bridge harmonious, and the basic rules were all as nearly adhered to as is often the case.

The Market Street arch at Youngstown, Ohio, designed by the writer, was a very difficult problem to solve on account of the side spans having to clear the railway tracks, and on account of the 4% grade of the roadway. The design, however, is symmetrical with the exception of the grade and the approaches, and was made quite harmonious by carrying the sub-trussing of the side spans through at the same elevation as the lattice truss over the arch.

The Mill Creek Park arch, while a short span, shows the possibility of designing artistic bridges for ordinary locations.

Comparing the Memphis bridge by Morison with the Thebes bridge by Modjeski, we can readily see how much is gained in architectural appearance by the symmetrical arrangement of the spans in the Thebes bridge. Comparing the approaches of the Thebes bridge with the approaches of the Forth bridge, we see how much more in harmony with the main structure are the approaches of the Forth bridge than those of the Thebes bridge, although considered alone the latter are of the best design architecturally.

The Grosvenor Dee bridge, at Derby, England, with its 200-ft. masonry span, is one of the greatest bridges of the world, but the paneling of the abutments and spandrels, and indeed all the decorations, are so out of harmony with the great span, that they dwarf it and ruin the design. Compare this with similar details of the Eden Park, Cincinnati, reinforced concrete arch and we find such ornamentation entirely appropriate and harmonious for the smaller span.

European bridges are more often well designed architecturally than those of other countries and the great bridge over the Rhine at Bonn, Germany, is an example where simplicity, harmony, symmetry and proportion are all as fully met and satisfied as has ever been the case in any bridge structure.

The Camelback bridge in the Imperial Palace grounds at Peking, China, is also one of the most perfect of the world's bridges from the architectural point of view and satisfies the cardinal requirements of design.

The best design in the United States is the Connecticut Avenue bridge in Washington, D.C., with its five great concrete arches, and very little fault can be found with the design, except the inappropriate decoration of the wing walls of the abutments. The designing of harmonious and appropriate details in the proper proportion is a study in itself and entirely beyond the scope of this paper. Should designers, however, carefully observe the cardinal principles herein laid down much more pleasing structures would result and a great stride forward be made in bridge engineering and architecture.

The necessity for good construction, especially of foundations, is obvious.

The total output of petroleum in the world for 1913 has been compiled from reliable estimates for foreign countries and from preliminary figures of the United States Geological Survey for the United States, and is given as about 378,000,000 barrels of 42-gallon capacity, as compared with 351,178,[illegible] barrels in [illegible]. In [illegible] the world's [illegible] 777,228 barrels, so that within a 7-year period, there has been an increase of over 80 per cent. The United States has furnished the greater part of the increase, and is at present providing almost two-thirds of the world's annual output. The [illegible] production of the United States [illegible] about 65 per cent [illegible] the world's [illegible].

REMARKS ON THE THEORY OF THE PITOT TUBE

DESPITE the great number of valuable papers and results of tests published during the past few years on the subject of the Pitot tube, hydraulic engineers have not as yet come to any definite agreement as to whether $h = \frac{v^2}{2g}$ or $h = \frac{v^2}{g}$ is the correct formula underlying its action. The following extracts from a paper read by N. W. Akimoff at the recent convention of the American Waterworks Association in Philadelphia, may be of assistance in clearing up a number of points serving as a foundation for argument. Mr. Akimoff is inclined to believe that the contention inherent in the controversies as to whether $\frac{v^2}{g}$ or $\frac{v^2}{2g}$ is correct, is mostly based upon the fact that entirely different premises are at the bottom of such discussions.

The formula $h = \frac{v^2}{g}$ is the same as $v = 0.7\sqrt{2gh}$ and it is not very difficult to build rods that will yield this result or even slightly less, instead of $v = c\sqrt{2gh}$, where c varies from 0.84 down to 0.75, as is the case in some of the rods now on the market.

It is often "assumed" that c really ought to be unity and, therefore, that smaller values of c are caused by the "suction," due to the "trailing orifice," bent back (Fig. 5, c) in the direction of the flow. It so happens, however, that out of all means available for decreasing the value of c, the "trailing orifice" seems to be the least effective; experiments made both in this country and abroad show that the lowest c that can be secured with the trailing orifice is 0.84 and often as high as 0.92, whereas, as said before, other means enable us to bring c down to 0.75 and even to 0.70. Greater "reliability" is claimed by the advocates of the "trailing orifice," however, which point it is not our intention to consider in this paper; our object being to present a few considerations relative to the formula itself of the Pitot tube, and not at all either to endorse or to condemn any particular existing article now on the market.

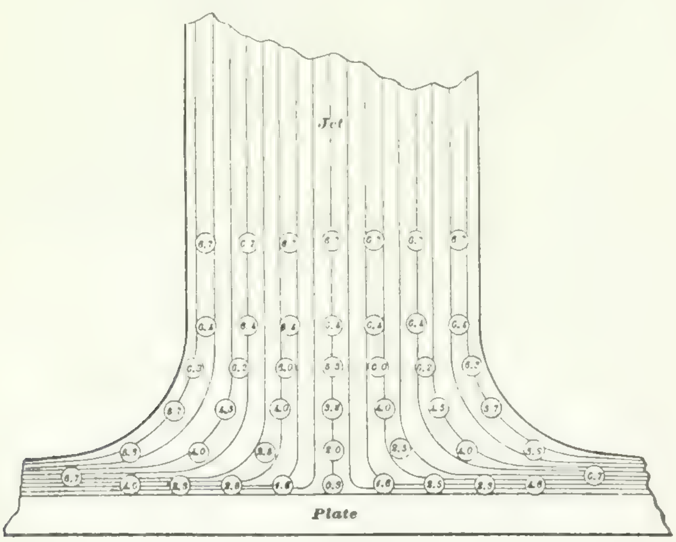


Fig. 1.—Stream Lines and Velocities of a Jet Impinging on a Plate.

We shall first take up the impulse tube itself; the "static" tube will be considered later. The writer will assume that everyone is familiar with the article on "The Pitot Tube; Its Formula," by Mr. W. M. White, published in the Journal of the Association of Engineering Societies, August, 1901. This article, which in our time will perhaps be found somewhat unconvincing, and, possibly a trifle obsolete, contains at least one valuable feature, which will be of advantage in our discussion. In order to substantiate his opinion that in an impact tube, whose impinging surface is one of revolution, the coefficient c, of conversion of velocity head into static head is exactly unity, Mr. White has made many tests, the results of one of which are given in a chart (Fig. 1), taken from his paper.

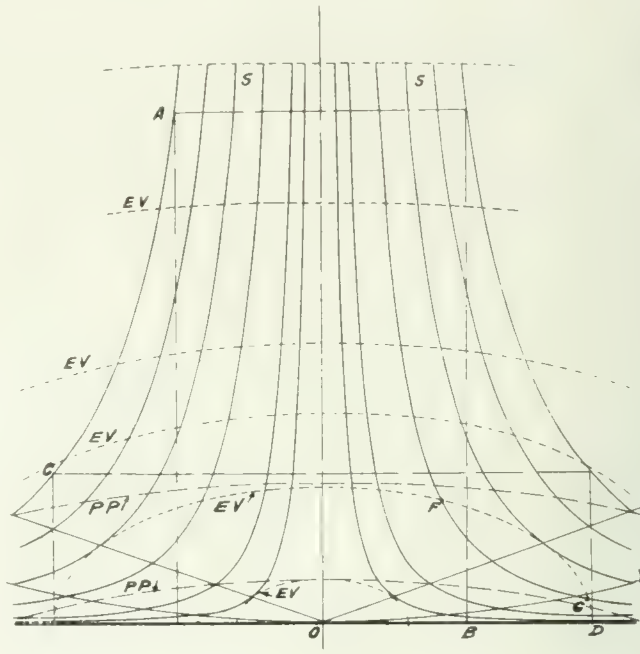


Fig. 2.

A stream of water was directed against a round plate; individual velocities of separate filaments were measured and the results, in feet per second, are marked on the chart.

At the present time it would not be necessary to take all this trouble, the effects of the stream, directed both against a long, narrow strip (dam) and against a round plate, have been carefully analyzed with the following most interesting results (Fig. 2, for round plate only).

1. The stream lines S are curves of third degree, possessing this most curious property: that all cylinders, inscribed in the surface generated by each stream line are equal, so that, for instance, the volume of A-B is the same as that of C-D. The stream lines began to diverge at a considerable distance from the plate. Of course, the size of the plate proper does not in the least affect the general shape of the curves.

2. The curves of equal velocity EV are ellipses, located as shown and having O as centre. Since, in general, these lines intersect the stream lines at two points, such as F and G, it is clear, that somewhere between F and G there must be a point of minimum velocity, where the corresponding ellipse is tangent to the stream line. The locus of such points of minimum velocity will be a straight line, OH, the angle of which with the base will be about 20°.

3. The curves of equal pressure PP will likewise be ellipses, but their common centre will be located below O and is not shown on our drawing. The curve of maximum pressures, (that is of points on each stream line, where the pressure is greatest for *that* curve) will be a hyperbola YOY, tangent to the plate at O.

Careful attention must be paid to the fact that the straight line OH, of minimum velocities, and the hyperbola YOY (of maximum pressures) do not coincide, so that minimum velocity does not mean greatest pressure, which excessive freedom with Bernoulli's theorem might lead us to think would always be the case. We readily forget that Bernoulli's formula has been established for parallel flow only and that it does not hold good for any other kind of flow; at least not in the shape in which it is given in books on hydraulics.

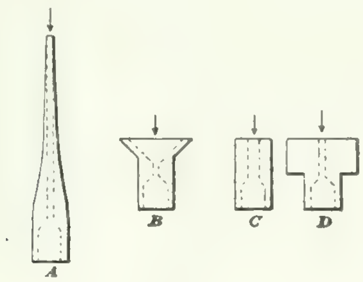


Fig. 3.

Such, then, is the correct aspect of the phenomenon of a jet impinging upon a round plate. A plate, long and narrow, would mean a somewhat different distribution of velocities, etc., and all lines would appear somewhat different from those given in Fig. 2. It follows, therefore, that contrary to the established assumption, the point O cannot possibly be considered the true impact point. Here the "static" pressure is indeed maximum, but the velocity is zero and therefore it is really the ideal point from which to determine the true static pressure, undisturbed by any "suction" or "trailing" effect.

It will, of course, be understood that this static pressure represents the conditions somewhere "up stream" from the plate itself; for instance in Mr. White's experiment, it simply shows the height from which the water falls. In other words, we have here not the "velocity due to a certain head" but the head itself. This may be made to serve as a check, but in itself is not especially instructive or interesting in our present problem. But then, it is perfectly possible and feasible so to calculate almost anything of this sort as to give fairly good results; only, our layout, Fig. 2, or, for that matter, the "practical" sketch, Fig. 1, as given by Mr. White, shows that the middle point is merely subjected to the action of dead water. We might as well have a stationary column at that point.

Any other point, in the vicinity of the curve YOY, of maximum pressures, will be more likely to register the effect of impact, due to velocity, in addition to static pressure at this point.

All the foregoing refers, of course, to a stream acted upon by gravity and directed downward on a horizontal plate, in other words to the condition, illustrated in Mr. White's sketch. In a pipe, with water flowing under pressure, the foregoing conclusions may require suitable corrections.

It is, nevertheless, quite obvious that the point which is generally assumed to be the true impact point, apparently placed against the greatest action of the stream, may prove to be at a great disadvantage, so far as the determination of velocity is concerned.

The size of the plate, as has been already stated, does not enter into our deductions; and the nozzles B, C and D (Fig. 3, taken from Mr. White's paper) will naturally cause the same distribution of velocities and the same effect. The nozzle B is in the same class, because our mere desire to "catch" the energy by means of a funnel-shaped orifice does not in the least alter the fact of the central stream being perfectly neutral, while other stream lines may, indeed, assume a somewhat more fanciful shape than that given in Fig. 2.

So far as the nozzle A is concerned (Darcy's shape), it must be remembered that, unless the nozzle itself is reasonably long, the fittings, etc., back of it should not be neglected. It will be easily seen that a large T or L piece immediately back of a very thin nozzle will cause the formation of stream lines similar to the foregoing, with the same inevitable effect, viz., the neutral stream, possessing the greatest static pressure, but inert, dynamically.

That the rod itself, beside the nozzle proper, will exert a certain influence upon the results, has been very clearly demonstrated by Professors Easby and Pardoe, of the University of Pennsylvania. In their experiments a comparatively small pipe was chosen and the rod was of uniform blade-like cross-section. By means of suitable stuffing boxes the rod was made to pass completely through and extend on both sides of the pipe; so that traversing the pipe meant merely shifting the position of the orifice, and not, as in other rods, the immersion of an additional portion of the rod proper. Under these conditions the traverse curve was materially different from the one usually obtained from such small pipe (4-inch). The curve was visibly more symmetrical and thus proved, beyond doubt, the experimenters' point.

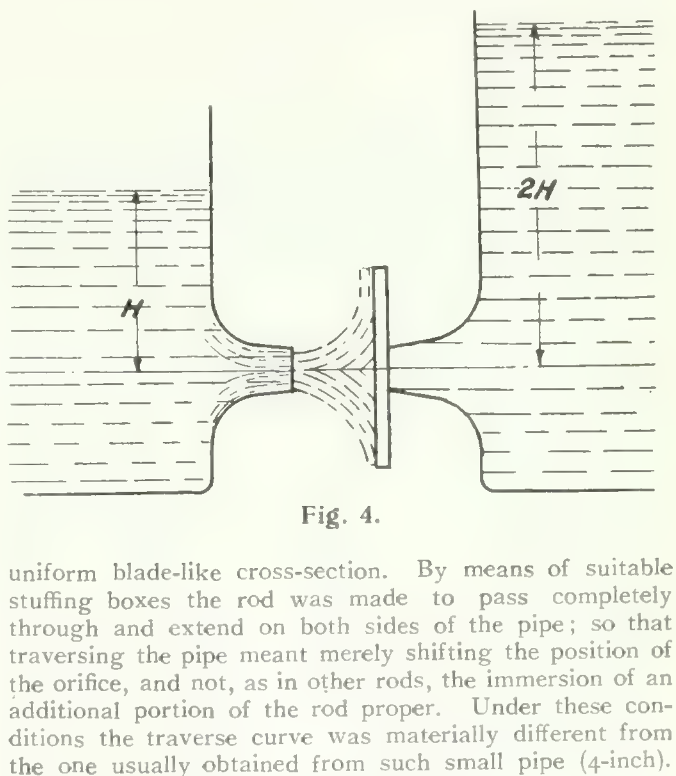


Fig. 4.

The fact has been long established in theory and confirmed by experiments of all kinds, that the *force* (*not* the pressure per square inch) due to an impulse of a jet is $M \times V$, mass times velocity, where the mass is the second-weight divided by 32.2 and the velocity is in feet per second, so that the result is in *pounds*. This immediately leads to $h = \frac{v^2}{g}$, in other words, to the conception of *twice the head generated by the velocity*.

That $M \times V$ is the actual force, due to an impulse, can be clearly proved by an experiment, similar to that described in Professor Merriman's *Hydraulics*, in the

chapter on "Dynamic Pressure of Water," where a jet, acting upon a plate in front of an orifice, is capable of sustaining twice the head, to which the jet itself was due (Fig. 4).

Should the plate be removed the head in both vessels tends to the same value, as was almost exactly demonstrated by Professor Unwin; but does such a condition correspond to our initial problem?

In an experiment of this kind, can we possibly expect any result other than an equilibrium, subject solely to corrections due to frictional and other losses?

Zeuner, if an impartial, conservative authority is to be quoted, in his well-known book on *Practical Hydraulics* (German or French), gives 1.25 as a safe value to be used in $h = \zeta \frac{v^2}{2g}$ while demonstrating that its theoretical value is $\zeta = 2$, he likewise cites a few tests made both by himself, in connection with turbine work, and by others, in experimenting on water scoops, etc., where the value of this coefficient was actually 1.25. Was this because the whole jet was utilized instead of only a small central filament?

Summing up the foregoing, therefore, and without the slightest desire to question the accuracy of the numerous tests, made by well-known experts, the writer does not feel, so far, there is sufficient evidence for the fact that in a single tube $h = \frac{v^2}{2g}$ is the greatest pressure that can be secured; and certain experiments, although made in perfect good faith, rather tend to demonstrate the contrary. So much for the impulse effect.

So far as the suction is concerned, we shall begin by referring to Mr. Ferris' discussion of the same paper by Mr. White. The following are Mr. Ferris' conclusions: (1) The suction effect of the trailing orifice is very little greater than that of the plain static opening, drilled through the pipe wall; and (2) the head, obtained by him was much greater, about 60 per cent., than $\frac{v^2}{2g}$.

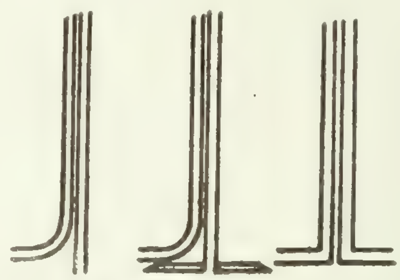
These remarks are very much to the point and we shall now endeavor to generalize them. To begin with, analyzing the suction effect due to the trailing orifice arrangement, one cannot help arriving to the conclusion that, owing to the comparatively low velocities, under which the Pitot tube is operated in practice, there is but little hope to secure any appreciable amount of suction by merely bending back the static tube.

Even in theory it can be proved that there is a certain minimum velocity, beyond which no suction can possibly take place (see Zeuner's book, hereinbefore mentioned).

But there is another point not to be overlooked; the so-called "static" opening, which is sometimes drilled in the pipe or else otherwise finished flush with a horizontal plane, cannot help registering *less* pressure than that corresponding to the "static" head, except, of course, for extremely low velocities. Here water is made to shoot past the opening and it is at this point that some suction effect might reasonably well be expected.

By way of illustration, beside Mr. Ferris' experiment, already mentioned, we might cite a few careful experiments made in Charlottenburg (Fig. 5, taken from Dr. Blasius' article, see *Die Turbine*, January 20, 1910). By k is meant the coefficient in $h = k \frac{v^2}{2g}$. It will be observed from c that the arrangement, which from the standpoint of "trailing" effect should yield the greatest k, actually is much inferior in this connection to the arrangement shown on sketch a, where the static pipe is finished at right angles to the flow.

It is perfectly easy further to intensify the real suction effect. It is well known that, as explained in hydrodynamics, a sudden change in the direction of velocity can cause very abrupt changes of pressure. For instance, in flowing around a sharp corner, even moderate velocities will cause zero pressures or even negative pressures (vacuum, and corresponding interrupted flow). This, then, seems to the writer to be the correct principle on which to work to secure the real suction effect, so that the value of c can be reduced to 0.70 and lower (in $v = c\sqrt{2gh}$).



(*a*) k = 1.82; (*b*) k = 1; (*c*) k = 1.18.

Fig. 5.

This has been experimentally demonstrated by Mr. Paul Lanham, engineer in charge of pitometer division at Washington, D.C., who had a special rod made according to a sketch suggested by the writer. In fact, the coefficient given by this rod seemed to be a trifle less than 0.70, although this rod was not standardized beyond establishing the above point of giving a very low value of c.

CANADA CEMENT COMPANY'S PLANT AT DAUNTLESS, ALTA.

Building operations are about to commence on the proposed $2,500,000 plant of the Canada Cement Company at Dauntless, Alta. There will be five kilns, each 10 feet in diameter, 240 feet high, and will weigh 600 tons. Including the fire brick lining and an average load of material, the weight will be 720 tons. These are the largest cement kilns in use in Canada and will be second largest in the world. A 10-ton gear, is required to drive each kiln and bearings, weighing 15 tons support the weight; while 16 cars are required to transport each together with bearings and gear. Over 3,000 yards of concrete are required for the five foundations. The cost, including installation, will be $75,000 for each kiln. The plant at Dauntless when completed, will have a capacity of 4,000 barrels daily, and will be one of the largest in Canada.

A bill has been submitted to the General Assembly at Uruguay for the construction of a canal to connect La Picada de Almeida, on the River Santa Lucia, in the department of Canelones, with the bay of Montevideo. This new waterway will be named the Zabala Canal. It will be accessible throughout its course by vessels of 200 tons displacement. The cost is estimated at [illegible]80,000.

The Pennsylvania Water and Power Co., has let contracts for the installation of an additional unit of [illegible] h.p. at its Holtwood (Pa.) plant. This will make the eighth unit, and will bring the capacity of the plant up to 111,000 h.p., with provision made for the installation of two more units, when required. Along with this improvement a new transmission line is to be erected between the Holtwood plant and Baltimore, which will take care of the increasing business in the latter city. This work will cost about $400,000.

ENGINEERING AND ACCOUNTING—THEIR RELATION WITH SPECIAL REFERENCE TO PUBLIC UTILITIES.*

By J. B. Scholefield.

AMONG the many changes brought by time none has been more complete than the change in the relations between Finance and Engineering. In times past the successful promotion of any undertaking involving the use or development of physical means was largely dependent upon the possibility of finding an engineer capable of handling the problems to be faced. The financial backing could be much more easily secured.

With the tremendous advance in engineering knowledge, and the heavy drain upon the world's finances caused by the unprecedented developments of recent years, the positions have been reversed. The necessary engineering skill can be more or less easily obtained, but, owing to the ever increasing demand and the multitudinous opportunities afforded, capital is becoming more and more difficult to interest. The requirements of capital are becoming more exacting and must be complied with to the best of our ability.

It is not now sufficient for the man of vision to paint a picture, for him to be overloaded with the necessary funds for its realization. Few projects are absolutely "in the rough" and estimates of the future must generally be verified from experiences of the past. This is particularly the case to-day when so many undertakings involve the replacement or reconstruction of the result of previous efforts. In many cases the profit to be gained is not what might be called an "original" profit but is often in the nature of a commission on increased efficiency or improved methods. The old gives place to the new but the latter pays for the sins of the former and the margin of profit is therefore reduced.

It is in these circumstances that the accountant has come into his own. Starting as the humble scribe to the "creative genius"—the engineer—he has to-day, in some instances, attained a position where the hopes of the engineer rest upon his decision. In all cases greater demands are made upon the accountant and the initiation and continuance of important undertakings depend largely upon the figures he supplies and not so much upon the sanguine expectations of the promoter or the developer.

The foregoing is even more true when we turn from the entrancing realm of exploitation to the mundane sphere of operation. With the increasing population and the disappearance of virgin fields for commercial development, financial attention is increasingly focussed upon existing enterprises and the possibilities for their betterment and economical expansion. Competition, including the competition between different means of production and sources of supply, calls for a closer watch upon the results of operation. Figures supply the medium.

Under these circumstances it should be apparent that it is to the mutual interest of the engineer and the accountant that they should co-operate to the fullest extent and should have a thorough understanding of the difficulties under which they each labor.

When I was asked to address your society it was with considerable misgivings that I consented, for "there is nothing new under the sun" and the setting forth of concrete facts such as an organization like this is interested in appear to me to be probably beyond my ability. However, it occurred to me that some brief remarks on the problems confronting the accountant in which he is dependent upon the co-operation of the engineer might be of value and, at this present stage of the country's political progress, a brief discussion of some points in the valuation of public utilities, in which they are both vitally interested, might be of interest.

In times past there have been unfortunate divergencies between the accountant's final figures of cost and the engineer's original estimates. This was doubtless the fault of the accountant but perhaps may be forgiven as attributable to his inordinate desire for accuracy.

The chief mutual interest of the engineer and the accountant centres round the question of costs. I do not now refer to manufacturing costs, with which we in this part of the country are not greatly concerned, but to the construction costs.

It is essential that the cost of construction be properly kept for the following objects:

(1) The vindication of the engineer.

(2) The scientific provision of depreciation.

(3) The reliable adjustment of cases of renewal and replacement.

(4) The provision of figures on which to base future developments or to recommend new and similar enterprises.

(5) The valuation of property for sale or amalgamation.

(6) The valuation of property for regulation or absorption by the state or federal governments.

The history of most undertakings has been one of small beginnings, and here occurs the first difficulty of the accountant. It is naturally felt, when capital is small and hardly obtainable, that the energy of the organization must be concentrated upon the physical work in progress. The accounting end is given small consideration and the records kept are meager and unreliable. In many cases the engineer is the paramount authority and is able, if he will, to insure the starting of a simple yet complete system which shall be of use in the future and can be elaborated as the enterprise grows. I have experienced instances where it was quite impossible to ascertain from time books or payrolls where the work was actually done and, as expenditure on similar work at several locations was all charged to one account, it was impossible to arrive at the cost of each plant.

The books are often kept at a point remote from the actual work of construction. The bookkeeper is unfamiliar with the nature of the work and the lay of the land and is consequently unable to provide intelligent and appropriate records. A preliminary outline by the engineer, showing the general plan to be pursued and the more important items comprised therein, should be provided.

In large undertakings it is worth while to keep elaborate detailed cost accounts in a separate set of books, the balances of which tie in to the controlling accounts in the general ledger. In smaller projects this is not possible and considerable unnecessary expense and trouble is incurred because the engineer insists on keeping his own records of cost for various parts of the work. This is probably necessary in such instances as require records of cost of excavation, grading, concrete work, etc., so that daily costs may be obtained as a check upon the progress made, but the cost of sections of the work can be adequately shown by the general books if there is a proper understanding between the engineer and the accountant

*Read before the Utah Society of Engineers, January 16th, 1914.

The former sometimes complains that the divisions adopted by the latter are of no service to him. Some preliminary agreement would doubtless have eliminated this excuse.

Unless the work will bear a heavy accounting cost, simplicity of accounting distribution is essential. I suggest that the following divisions will sufficiently cover the majority of cases (excluding large enterprises):

Material and freight.
Labor.
General expense.
Overhead expense.
Financial expense.

The first three divisions would be titles of accounts for each part of the work sufficiently important to call for separate accounts. Overhead expense and financial expense would, of course, be each in one account for the whole project.

The reason for choosing the first distribution is that, in the West, at least, the delivered cost is the important figure. This account should therefore include hauling and handling. By arriving at the unit cost under this head at the completion of the work it will be possible to make comparison in future years when the questions of replacement, renewal, or reconstruction come up.

The common labor cost should be a separate item because rates change so frequently and much of this work is eliminated from time to time by inventions and improvements.

General expense would include all other expenditures directly chargeable to the section of the work. It may be that engineering is so large an item that a separate account would be desirable. This depends upon the individual circumstances. I shall probably be told that my distribution makes no provision for stores accounts. Needless to say, stores accounts are extremely desirable if properly kept. Unless, however, a regular store-keeper is kept and a proper system followed, the result is more unreliable than that obtained by making direct charges to the accounts estimated to incur the expenditure for material and supplies.

Overhead expense should not include Financial expense but should cover only such supervisory and executive expenditure as cannot be directly charged to any one section of the work.

Financial expense, which includes promotion expense, discount on bonds and stocks, interest during construction, incorporation fees, etc., should be kept separately. It is absolutely unjust to charge this as a part of the cost but it is often spread over the property so as to hide the expenditure. The conservative method is, of course, to hold this expenditure apart and charge it off to profits over the life of the indebtedness incurred or as a yearly charge over the estimated life of the assets created by the work.

It will readily be seen that the accountant depends upon the engineer for the proper distribution of expenditure and it is therefore the business of the latter to see that he has the means of supplying reliable information. I need only mention two or three desirable methods in this connection:

(1) Blind check on material received.

(2) Proper issuing requisitions.

(3) Individual daily time slips. The usual time book is a delusion and a snare and leaves the way open for a shirker to neglect the conscientious discharge of his duty.

(4) In case of a more or less elaborate distribution the adoption of letters, numbers, or symbols as a means of reducing the labor of distribution.

(5) Correct records of material returned either to seller or to general stock.

(6) Correct records of material remaining on completion of construction.

Let me point out some errors which are not infrequent and which can be avoided if the necessary information is furnished to the accountant:

(1) Construction originally charged to property account is torn down and replaced by improvement. The cost of tearing down should not be a property charge.

(2) Supplies are charged to property by one company and then sold to an allied company. The sale is credited to earnings.

(3) Property is "junked" and turned into storehouse without record. There is a surplus on inventory which is credited to profits.

(4) Property is torn down and the material used for maintenance without charge.

(5) Overhead and financial expense are omitted from original cost figures when writing off property replaced.

(6) Supplies left over from construction are not turned in to stores or records furnished. They are later sold as operating supplies or used in maintenance without charge.

In the course of the work the main plan will often be modified and the accountant should then be supplied with a simple and timely notification of the change involved.

The distribution of overhead expense cannot be done intelligently without the advice of the engineer. It is entirely wrong to spread this over according to the total cost of the work. In some cases there will be a large labor charge, involving much overhead expense, with little material charge. In another case there may be a low labor charge with the same amount of overhead expense. In another case there may be a comparatively small material charge on work which has occupied much time in contemplation, planning and supervision. In some cases a low labor charge may mean that the class of labor employed required constant supervision and in other cases a high labor charge may mean that much could be left to the intelligence of the men employed.

The engineer should take the completed cost figure and, from his files and his personal knowledge, make a concise report on each division of expenditure so as to indicate the proportion of overhead expense which should be borne by each.

On other points the engineer can and should furnish information. Take, for example, the question of the charge to be made by one project for equipment loaned to another. This charge may be made either by way of interest and depreciation charge upon the value of the equipment when received, or by the difference between its estimated value when received and when returned, plus in each case an agreed profit.

It often happens that the construction and operation overlap and that the construction force is used to a greater or lesser extent in the commencement of operations. In that case operating must be charged with certain time, both ordinary labor and supervision, for supplies used and facilities provided. The information must come from the engineer. This also applies to the proper division of revenue obtained in the transition period.

Certain parts of the work bear, in some instances, what appears to be excessive cost. Only a proper engineering report can interpret the accountant's figures in the light of the difficulties actually encountered so that future valuation and present opinion may be correctly informed.

When actual construction is completed, the engineer can greatly assist the accountant in two ways:

(1) By giving information as to desirable divisions of operating and maintenance expenditure so that the records kept may afford valuable information. He may also be able to suggest proper classification of earnings. This side of accounting is often neglected but is very necessary in comparing periods and in arriving at facts relative to progress and the probability of increase in the future and the justification for additional construction.

(2) The fixing of logical and adequate rates of depreciation. This can be done by a detailed report on the class of construction in each account, its probable life, the estimated maintenance charge and any other useful points. The general practice of using a blanket rate of depreciation to cover a whole plant or even large sections is absurd. The whole question of depreciation calls for a change in treatment. To my mind, the only correct method for a large plant or system is the provision of a depreciation and maintenance fund. After proper consideration by engineers and all concerned the probable yearly depreciation and maintenance cost on the several sections should be determined. This cost should be charged up by even amounts monthly and credited to the depreciation and maintenance fund. Against this fund should be charged the actual expenditure for maintenance, replacements, and renewals and complete reconstruction if the property is rebuilt (if the original construction is exactly replaced). The division of the actual expenditure can, if desired, be kept in subsidiary books.

The advantages of this plan are that comparative accuracy is insured in the rate of depreciation and that the cost of maintenance is equitably distributed so that the earlier years, in which the plant is new, and the expenditure on maintenance is small, bear their fair share. It may be objected that the business is built up in the earlier years for the benefit of the later years. This has been the excuse for manipulations which are responsible for many of the evils we suffer from to-day. In any event, if this contention be allowed, the honest method would be to make allowance for the "building up" process by crediting earnings with an estimated amount and carrying a corresponding charge as deferred for distribution over later years.

Where assets are replaced by improved or enlarged units or parts it is naturally claimed that the increased value should not be charged against earnings. It is necessary, therefore, to charge the cost of original plant cost to earnings and the improved value to capital. The accountant must obtain his data from the engineer as the one familiar with the actual physical change. It is hardly necessary to say that the present day cost of the lost asset should be charged to earnings, not the original cost.

The operating statements issued under this system show a uniformity which is extremely useful as a basis for further capitalization or the marketing of present securities.

A periodical reconsideration of the depreciation and maintenance funds and charges thereto must be had in order to correct the results of any exceptional occurrences or conditions.

The rates fixed should take into account the residual value of the property in reduction of the annual charge.

Depreciation should not be provided on such expenditure as does not require replacement. Therefore, real estate, perpetual right-of-way, excavation and grading, and like items should not be included as depreciable.

The income tax law allows "reasonable depreciation." At first the deductions made under this head will doubtless escape minute scrutiny, but as the Act works more smoothly the authorities will certainly turn their attention to this feature. We shall depend upon the engineers to substantiate our contentions as to rates and conditions. It would probably be of great benefit if this society were to take up the question of depreciation in this section of the country, having special regard to the effects of atmosphere, water, and soil conditions and set forth a schedule of depreciation on well-known standard apparatus and material so that these figures could be used to combat the generally erroneous conclusions of government officials. A result of government rate fixing can be seen in the maximum rate of "5 per cent. of the annual gross outfit" allowed to mines under the income tax law. In the case of one mine with which I am familiar, a mine which is a big producer, it would require 42 years to wipe out the investment if the allowance were based on last year's production, or 30 years if the market value of the stock is considered.

The Supreme Court decided that mining companies could not deduct, for depletion of assets, the difference between the value of ore sold and the cost of extraction. This leaves us without any measure of depreciation, if, indeed, any is permitted to mining companies on other than constructed assets—another instance of governmental accounting. The income tax law corrects this but the decision may serve as an instance of what we may expect from cases brought before the courts.

When we turn to the special instance of public utilities we find that the relation of the engineer and the accountant is particularly important. These undertakings depend for their financial life upon the contributions of a class daily becoming more sensitive—the investor. No longer can the word of one financial power call forth unlimited means for any project receiving his benediction. Facts and figures, verified to the utmost possibility, are demanded and given.

In large projects the continual progress must be shown so that an idea may be gained of the eventual outcome. Additional capital can only be obtained after thorough investigation and, in the capital-limited future, the most favored treatment will be received by the corporation able to show actual and provable figures so arranged as to form useful guides to the twice shy investor.

There is another phase of the future which is of even more importance. I believe that most of us will agree as to the practical certainty of one of two things in the near future: (1) State or government ownership; (2) absolute regulation as to rates or capitalization or both. In either instance some valuation must be made and it will not be the same in both cases. Presumably the government would decline to pay for money not actually invested, whereas if rate regulation only were desired, some provision would be made for the risks attendant upon continued ownership. It may be claimed that court decisions concede the value of some intangible costs, but it would appear reasonable to assume that, in the event of a federal scheme for ownership of interstate utilities, some means would be adopted of overcoming the restrictions imposed by past decisions—some of them contrary to a reasonable conception of public rights.

If the valuation be for purposes of rate fixing it is certain that the value must include all money actually expended, together with the cost of obtaining same and a reasonable compensation for unproductive years. This may include some excessive items but the community

must assume some responsibility for its errors of the past or for the provision of facilities before the locality was ripe for them. The question of depreciation cannot concern the rate-fixing body as a factor in the price to be calculated but only as a factor increasing the rate to be allowed. The depreciation should be allowed on the new value of the plant and cannot be claimed at a figure sufficient to make good the ravages of time in a plant where repairs and renewals have been neglected. On the other hand, appreciation of value cannot be claimed for this is the result of the gift or increase of the very public for whom relief is claimed. In the same way a franchise can have no value other than the actual legitimate cost of obtaining same.

Valuation of public utilities for absolute purchase may be affected by a government right to install competitive plants in case of alleged exorbitant demands on the part of the public utility companies. Assuming that both sides are reasonable in spirit, we may fairly claim that the corporation is entitled to payment for cash actually expended, a reasonable financial cost, the average market valuation for some period prior to proposals of government ownership for the stock issued purely as bonus, a reasonable compensation for the market building period (such compensation to become less as the company grows older) and some value for appreciation where the far sightedness of the promoters can be shown. Depreciation not made good would undoubtedly be deduced and regard would be had to the conditions of ownership and operation as they had affected profits.

The ethics of government acquisition may be said to rest upon the assumption that value conferred by the people may be taken by the people, after allowing reasonable compensation for private capital employed and risks undertaken. Assuming the accuracy of this assumption it is evident that little value will be attached to franchise rights, appreciation through increase of population or age of property, promoters' bonus (except where represented by stock which has acquired a market value in the hands of "innocent" holders), and similar terms. It is therefore essential to show all the legitimate expenditure involved and that records should be easily verified and explained. Corporations able to supply information readily and clearly are likely to receive better treatment than those which must resort to estimates and put forward claims not represented by actual figures.

The presumption stated above excludes all question of replacement value. This method of valuation must be resorted to when original records are not available but is fraught with dangers. If credit is taken for the increased prices of the later date it would be perfectly reasonable to insist that the heavy promotion and financial bonuses imposed in the past, but no longer tolerated by public opinion, be eliminated. If, however, by replacement value we mean the cost to replace the original construction at the original figures, the value of correct records is again evident. There are, however, some values which, under ordinary bookkeeping methods, would not be recorded. Such values are those for right-of-way and land donated and taxes remitted. These have a legitimate value to the company and should be recorded by the man on the spot, the engineer, through his report or by notification to the accountant who can record same by a ledger account note or in some other appropriate book. On the other hand, there are certain recorded expenditures which are not represented by assets to which the corporation has title. These include such expenditures as are made on city streets and in other public places in consideration of rights or privileges acquired. A physical valuation of the property might overlook this cost unless specially segregated on the books or specifically reported.

In conclusion, let me express the hope that this somewhat random paper will stimulate interest in the accounting work of enterprises with which you may be connected. Interest is prone to wane when construction is completed and the humdrum work of operating begins. You can, however, usefully give some attention to the operating records. By suggestions or instructions as to proper division of earnings, by information as to which parts of the property or types of the construction are deserving of special record as to operating costs and results you can ensure useful records. Correct and reliable statements breed confidence, and confidence is the forerunner of enterprise. When enterprise is widespread we all gain, and in the creation of confidence one project successfully constructed and operated is worth a hundred glowing prospectuses.

This paper does not exhaust the subject and is written more as a basis for discussion than as containing only incontrovertible facts. I shall therefore be glad to endeavor to answer any questions which you may care to ask.

SMALL STONE FOR ROADS.

It is a usual custom to specify that no stone in a broken stone road shall be over 2½ inches in diameter, because it is claimed that if larger it will work to the surface. If a mass of loose stone of various sizes is passed over by wheels there is no doubt the larger stones will tilt up when the weight comes upon one end of them and the smaller stones will roll down into the place made vacant; but it does not follow that in a broken stone road rolled with a steam roller and bound together with the addition of fines, that a stone will work to the surface if it is 2 inches below the surface to begin with. In fact the mass is so perfectly bound together that it is impossible for tilting to take place, therefore larger stones than 2½ inches can be used in road construction, especially for the lower course.—Canadian Municipal Journal.

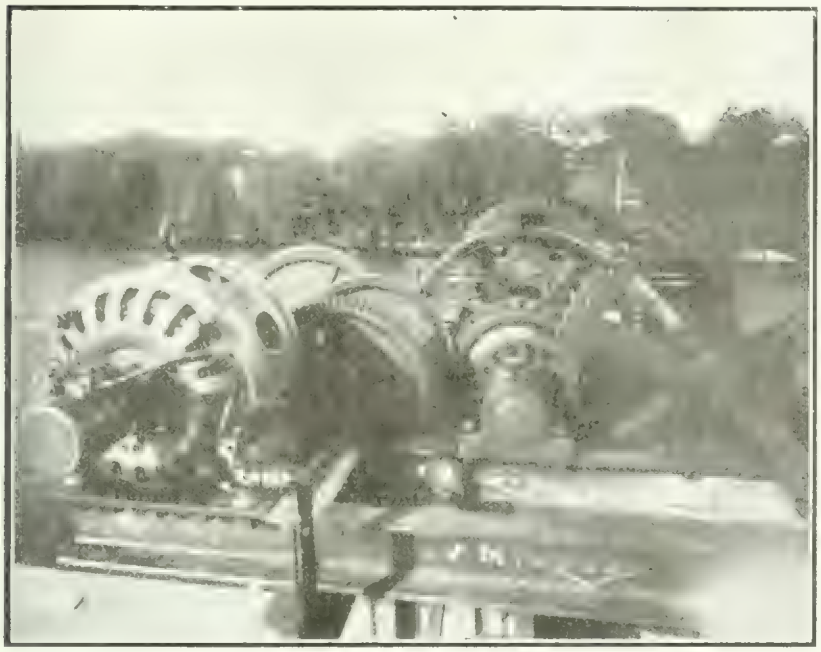
A steel car of special design is being adopted by the C.P.R. The roof of the car has been made in the form of a compromise between the clerestory and the turtle back types, and seeks to retain as far as possible the advantages of both, offering the maximum of light and ventilation. The car is 10 feet in width and 82 feet in length and seats 84 persons.

A compromise bill to regulate the water power diversion rights at Niagara Falls has been agreed upon at a conference held on May 13 between the Secretary of War and representatives for the United States of the House of Foreign Affairs Committee. The bill gives the Secretary of War the right to issue revocable permits for a daily diversion averaging 15,600 cubic feet per second on the American side, and the importation of 250,000 h.p. from the Canadian side. The control over the rates, tolls and service is to be left to the state of New York.

A contract has been recently made between the Italian State Railways and the Società Italiana Westinghouse, of Vado, Liguria, for the electrification of the 27-mile railway between Genoa and Savona; and the electrification of the 30-mile railway between Savona and Ceva, has already commenced. Work of electrification of the Genoa-Savona line is to be completed within 3 years, this line forming part of the railway between Genoa and Marseille, France. By June 1st the railway between Savona and Ceva will have been electrified as far as San Giuseppe (11 miles), one of the principal thoroughfares for the coal-carrying trade of northern Italy. Electricity will be utilized for the freight as well as the passenger services of these lines, and the electric locomotives to be used will be the same as those now in use on the Italian railways from Genoa through the Apennines and the Giovo, which were made by the Società Italiana Westinghouse.

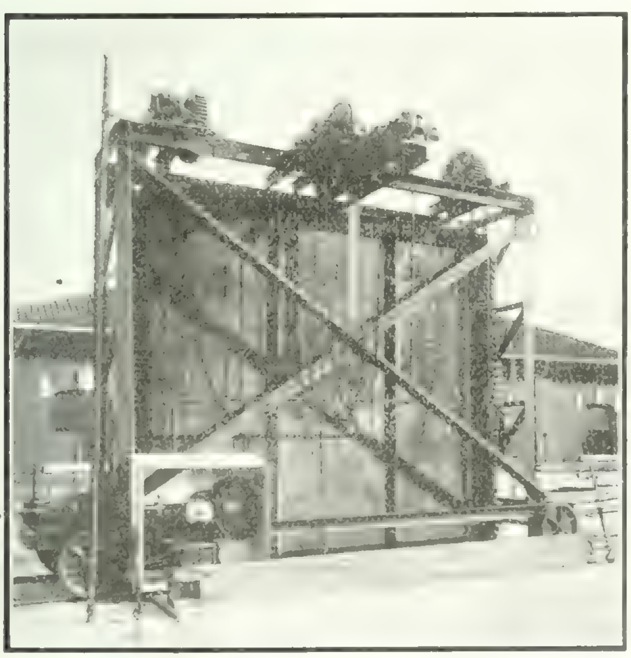
NOTABLE SLUICE GATE ON OTONABEE RIVER.

THE Auburn Power Company development on the Otonabee River possesses a number of interesting features, among which might be mentioned the specially designed travelling sluice gate by means of which the water can be shut off from any of the five wheel pits. The accompanying illustrations show this sluice gate and the gearing whereby it is operated.



Operating Mechanism of Travelling Sluice Gate.

The Auburn Power Company, which was purchased about four years ago by the Electric Power Company, operated a plant for a number of years consisting of one 250-kw., 2,300-volt, three-phase, 60-cycle generator and exciter; one 100-kw. and one 40-kw. unit, both 550-volt, d.c., compound-wound railway generators. These were driven by water wheel and supplied light and power to Peterborough and power to the Peterborough Radial Railway Company. Upon purchasing the plant, the Electric Power Company planned a larger development, the construction of which took place in 1911.



Sluice Gate in Raised Position.

The main dam is situated about 1,200 ft. north of the power house and is constructed of concrete with piers 6 ft. thick and stop-log sluices 20 ft. wide. Its maximum height is 24 ft. and its length 452 ft., including the intake to the head canal, which occupies a total width of practically 100 ft. Each sluice has a depth of 10 ft. below normal head water level and provides a total discharging capacity of 26,000 cubic feet per second. The stop-logs of both intake and dam are handled by chain winches.

The head canal, 1,200 ft. long with sides sloping 1½ to 1, and faced with 9 inches of reinforced concrete, varies in width from 74 ft. near the head works to 83 ft. immediately above the power house.

Articles dealing with the design and construction of this interesting plant appeared several years ago in *The Canadian Engineer*, but the above data are given to better describe the sluice gate with which this article deals.

Of the five wheel pits, four were designed for power units and the fifth for the exciter turbine unit. Each wheel has a net entrance area of 224 square feet to shut off the water quickly and completely in cases where repairs or examination of the turbine gates or runners are necessary. The Stoney sluice manufactured by Ransomes and Rapier, Limited, and illustrated herewith, was installed. The dimensions of this gate are 15 ft. 3½ in. wide and 14 ft. 3 in. high. It is constructed of a riveted boiler plate and supported by a travelling gantry of structural steel, as shown. The apparatus is mounted on cast-iron wheels 2 ft. in diameter with a 9-ft. 8-in. base. It operates on rails at standard gauge.

The arrangement whereby the sluice gate can be lifted or lowered even under a full head of water with the turbine gates opened full, consists of a set of circulating rollers on each side to run in the concrete stop-log gains. When the gate is closed leakage is minimized by the settling into place of adjustable side bars.

The gate is fitted for both electrical and hand operation. It may be raised or lowered against quickly running water passing through the opening under the maximum available, in the space of 2¼ minutes by electric motor. If operated by hand, lowering takes 4 minutes and raising 60 minutes.

The mineral production of coal and coke in British Columbia [illegible] No. 1, 1914, of the British Columbia Bureau of Mines as follows:

Minerals.	[illegible]		[illegible]		Increase or decrease.
	Quantity.	Value.	Quantity.	Value.	
Coal tons, 2,240 lb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Coke tons, 2,240 lb.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Building materials, etc.		[illegible]		[illegible]	[illegible]

ENGINEERS' ESTIMATES AS THEY AFFECT THE CONTRACTOR.

THE following article, from a paper read by P. R. Fletcher, to the Illinois Association of Municipal Contractors, of which he is president, has to do with a number of points of interest both to engineers and contractors.

The United States government, the legislatures of all the states, the officers of every city, village and town, annually levy an appropriation to pay the expenses of running their respective governments for the succeeding year. Every railroad company and industrial corporation in like manner makes an estimate and appropriation for their corporate expenses. This must be done in order to keep the cost of operation and maintenance in reason and to limit the entire cost to a fixed sum of money which they anticipate receiving.

In like manner the engineer in preparing his estimate of the cost of any improvement should with care and deliberation go into all details and arrive finally at a sum which will be sufficient to pay the total cost of this improvement and all expenses connected therewith. This estimate should be ample and liberal to allow for all the requirements of construction and the contingencies which might arise.

There is occasionally an estimate for public work in the territory in which I have operated, that I would call reasonable; there are some that are fair, more that are low—and some, very low. Engineers' estimates are invariably low. I have therefore taken for my text the following clause, found in every special assessment proceeding in the state of Illinois: "I hereby certify that, in *my* opinion, the above estimate *does not exceed* the probable cost of said improvement and the lawful expenses attending the same and connected therewith."

In that one word "my" lies the authority for the estimate, the value of the estimate, and whether or not it is adequate for the construction of an improvement. By that one word the state of Illinois has given its authority to an individual to carry out its constructions and to prepare an estimate for vast sums of money. It has not hampered him except as to the word "exceed" and, as everything is left to his personal opinion, the value of that word is negative.

At the first sight of this certificate, one would think that this estimate must be exactly what the proposed work would cost, and could not exceed that sum. That is what it is intended to be, but, with the fluctuations of labor and material, and other causes, estimates vary a great deal, and if not made with due care, by an engineer who has had a great deal of actual experience and who has kept cost accounts on construction work, will often prove insufficient.

The city engineer who does all his work in one city becomes familiar with all the conditions entering into the cost of work in that city, and usually makes conservative and reasonable estimates. On the other hand, if he uses the same schedule of prices of labor and material upon going to some other city or village, the estimate may vary either way, and if too low may cause the non-letting of the contract. Again, there are many instances where the engineer has made fair and liberal estimates, according to his judgment, but has been compelled to lower them on account of the opinions of some members of boards of local improvement, who consider the estimate too high for that particular locality. Low estimates often result in the failure to let the contract and the abandonment of the proceedings, the letting of the contract above the estimate necessitating a supplemental assessment, or the letting of the contract to undesirable contractors.

Less than a decade ago estimates of cost, both by engineer and contractor, were generally mere guesses. Both, however, are beginning to realize the value of keeping construction costs. Both in estimating and in carrying on construction, methods and costs are taken into consideration, so that a better understanding now exists as to the difficulties to be overcome in construction work.

Though every engineer and contractor has a different method of making estimates of costs, in the main and important details they are similar. For example, anyone estimating the cost of concrete per cubic yard can obtain prices from the dealers on the aggregate, sand, cement, steel and lumber. The exact amount of each material needed for a cubic yard can be calculated and set down without any guessing. There are only two items—the cost of mixing and placing and the cost of erecting and removing forms, both items of labor—that remain to be estimated. By consulting some practical concrete man who does this kind of work, or taking it from cost records, the estimator can ascertain the cost of these items. Adding to it allowances for plant and general expenses, the contractor's legitimate profit and discount of paper, he has a fairly accurate estimate. This method reduces guesses to a minimum, and instead of a guess in a lump sum, what little must be done is confined to a few items, generally a small per cent. of the whole. Those who follow this method and do much estimating will soon learn the various man and machine units of work per hour or per day, so that the only uncertain element of labor cost will be the fluctuation of wages.

There are many conditions which affect the fluctuations of wages. Men may be plentiful when a job starts, but wages may increase, due to the beginning of other work in the same locality or generally good business conditions, and labor become difficult to obtain. In many cities, labor unions are in control of the situation and a union scale of prices is in effect and must be met. In many smaller villages and cities, no satisfactory floating supply of labor is to be obtained. The contractor must import laborers and provide a place to sleep and feed them, an added cost on small contracts. Wages paid to local labor are always higher for an outside contractor than the prevailing local scale, usually about a 25 per cent. increase.

Local laws may also affect the labor costs. City ordinances imposing regulations on maximum loads, etc., may increase the cost of the work. The engineer must look fully into the wages paid in any locality where work is to be done and also into the many conditions which might arise.

Look Out for "Contingent Costs."—In the case of materials to be used, there should never be any guess work as to their cost. Before the estimate is compiled, prices of all the materials, based on the approximate amount needed, should be obtained in writing from the manufacturers or dealers. In the request for such prices, it should be stated what the materials are for, and about when and where they will be required.

Every contractor is familiar with the items of contingent cost encountered in nearly every specification. He reads them over and says to himself, "Oh, that isn't much; that doesn't amount to anything." It does not, if there were only one; but, taken in the aggregate and put into dollars and cents, it represents a large item of cost. If he does not figure it, his profit is reduced; and the

probable reason he has never figured it out is that he could not get his bid under the engineer's estimate if he had—for the very reason that the engineer had omitted it also. Here is the big question: "Do engineers ever figure the contingent cost and add it to their estimated cost?" I believe that here is the true reason why many estimates are too low.

The following items of contingent cost enter into nearly every contract:

1. Expense of looking over the proposed work, attending the letting and closing the contract, if successful.
2. Attorney's opinion as to legality of the special assessment proceedings and bond issue.
3. Cost of the surety bond.
4. Cost of maintenance bond.
5. Cost of the liability insurance policy.
6. Moving outfit to and from the work.
7. Plant maintenance.
8. Tools lost, broken and stolen.
9. Wasted material.
10. Demurrage.
11. Losses due to weather conditions and damages of the elements.
12. Pay roll and expense of outfit in rainy weather.
13. Pay roll of superintendent and foreman for three months of the year, when not at work.
14. Local charges for use of water.
15. Broken drain or water pipes.
16. Unforeseen damages to walks and private property.
17. Cost of inspection of materials.
18. Stakes and help for the engineer.
19. Barriers and red lights.
20. Lost, torn or damaged cement bags.
21. Being a good fellow.

I could explain each of these items more fully, but the mere mention of them will suggest many instances to every contractor. Every one of these items enters into the cost of an improvement. Each is as much an item of cost as labor and material. Taken separately, they amount to but a small sum, but in the aggregate they total from 10 to 15 per cent. of the cost of an improvement. How many engineers take cognizance of these items and include them in their estimate? Yet their specifications and contracts call for them.

No business can succeed without profits, and no contracting company can succeed, and stay in business, without them. This leads to the question, "What constitutes a fair net return on municipal work?"

The contractor's profit depends on the price he bids for the contract, and often varies for the same class of work. In early spring he may bid very low, to get his organization ready for the season, especially if he carried no work over from the preceding year. Later on he, perhaps, obtains contracts at legitimate prices, thus averaging up on the year's business.

On force account work, with every facility at hand to do work, the usual allowance for use of tools and profit is 15 per cent. Gillette figures profit on the basis of 10 per cent. on the cost of material and 33½ per cent. on the cost of labor. This would probably average about 20 per cent. on the whole contract.

Contractors for municipal work are paid in cash or bonds. The occasions when they are paid in actual currency are so rare that they need not be discussed. These bonds are of two kinds: the municipal bond, guaranteed by the city or village as a whole; and the special assessment bond, issued by the city or village in anticipation of the collection of the tax upon each lot or parcel of land benefited by the proposed improvement. Here are two classes of bonds issued by the same city or village for the payment of the same class of work, each drawing 5 per cent. interest, each taken by the contractor at par, yet of very different market value.

The special assessment law of the state of Illinois is considered very much superior to the similar laws in Iowa, Wisconsin and Indiana, irrespective of the fact that where only 5 per cent. interest is paid in Illinois 6 per cent. is paid in these other states. The special assessment bonds of these states readily sell for par, owing to the increased rate of return on the investment, and the public buys them for the reason of that particular attraction. The Illinois bonds assessed on relatively the same kinds of property are sold at a discount of from 5 to 10 cents on the dollar, in order to net an average of 6 per cent. or more for the time that they have to run.

Here, then, we see the propertyholders paying nominally 5 per cent. on an inflated cost of an improvement according to the state law, but paying 6 per cent or more on the actual cost. This difference of cost of the work, ordinarily termed discount, must be added to the engineer's estimate as a part of the cost of an improvement. This discount is not always 5 per cent., but varies as the money market changes. When money is plentiful, bonds can be marketed at 95, but during the last year many have sold for less, if they could be sold at all.

Special assessments are levied against every lot or parcel of land benefited by the improvement, according to such benefits, and the assessment must be equitable. The amounts so assessed are spread irrespective of the value of the lot or the owner thereof. If the property assessed is improved, the value is greater and the security behind the bond is increased. If the property is vacant and poor in value, it has a tendency to decrease the security of the bond, unless it is so located that its improvement or the growth of adjoining property enhances its value.

Again, many assessments are spread against property which has been sold for taxes and been forfeited to the state. In this case, the state pays no special assessments. Hence, in looking over proposed improvements before the letting, the contractor usually examines the assessment and if he finds property forfeited to the state, it reduces the amount available for the construction of the improvement by the total amount of the forfeitures. If the estimate, after taking off the forfeitures, is too low to do the work, the contractor either must not bid at all or else must bid above the estimate. From these facts it follows that it should be the duty of the engineer to look over property before making his estimate, to ascertain its condition, and make his estimates accordingly.

Make Sure of Value of Bonds.—The first duty of the contractor, when he receives bonds for work, is to see that they are good. He must depend upon the expert attorney to advise him. But such advice, however favorable, will not force a propertyholder to pay his tax for an improvement, nor will it force the state to pay a tax upon a lot which has been forfeited to the state for non-payment of taxes. No special assessment bond becomes forfeited if every lot or parcel of land pays its tax. If property that is assessed for special assessment improvements is clear as to title and is worth as much or more than the assessment, there is not much doubt of the assessment being paid. It is this doubt or possible chance of a forfeiture that bankers and bond-buyers shy away from. They use it as a club to force the contractor to sell his bonds at their price. After having the opinion of the expert and of

their own legal talent as well, they send representatives to look over the property assessed, and if there is no possible chance of a loss, the contractor may be offered 95 per cent., if 30 per cent. of the property is vacant, 92 per cent. If there is a forfeited lot, he will get no offer at all.

I am going to suggest two remedies that I am positive, if made law, would have a good effect on the market value of these bonds. As they depend upon the engineer's estimate they may properly be included here.

First, the engineer's estimate should be ample; enough so that after paying the contract and the 6 per cent. allowed by law for the expenses of making the assessment, court costs, etc., there would be left a residue. Our present law requires that after the cost of an improvement is determined, the residue shall be rebated to the propertyholders before they pay their assessments. They pay only what is actually required. My suggestion is that no rebate shall be made until the final bond is paid. I contend that if the property owner elects to take five or ten years to pay his debt, he should pay all expenses connected with it. I contend that the contractor should not assume the collection nor stand the responsibility of the non-collection of special assessments. If there were a residue or reserve left in the special assessment fund, over and above the obligation or requirements of that assessment, it would undoubtedly go far as a guarantee toward insuring the full payment of every bond and the interest thereon, in case of a possible default in the payment of some installment.

Secondly, 6 per cent. is allowed by law to reimburse general fund accounts for cash advanced on account of the expenses of levying all assessments, and this 6 per cent. is always drawn from the first installment. Thereafter there is no fund to pay any expenses which may develop on account of the special assessment. If some of the propertyholders pay their assessment in full, the interest stops on their portion but the bonds continue to run until called. Here is a loss of interest and no fund to pay it. There might be a default on some payment of an assessment and no fund to pay it. The bonds are obligations of all the propertyholders, and inasmuch as the state has seen fit to assess them 6 per cent. for the making of an assessment, I can see no valid reason why another assessment of, say, 5 per cent. should not be levied and held as a sinking fund or reserve, to pay the loss of interest and forfeiture, if any, and at the final payment of the last bond to be rebated to the propertyholders.

The assessing and creation of this reserve will, in my opinion, bring the value of special assessment bonds to a higher plane as marketable and investment securities. Contractors who, in bidding heretofore have figured a return of 90 to 95 cents on the dollar, would, if these provisions were a law, be able to figure on the basis of nearly par. If the creation of this reserve acts as I think it will, I cannot see that the propertyholder eventually pays any more than he does at the present time. What he now pays for as discount will be offset by the increased value of the bond.

The present state law requires that interest shall be paid upon all of an assessment except improvements put in upon the one-year plan. There are a great many such improvements, so small in total amount as to dollars and cents that it is impossible to make them in 5 or 10 installments, where each installment must be a multiple of $100. Very often these improvements are put in in the early part of the season or late in the fall, and in either case, the contractor must wait a year or year and a half for his money without interest. I believe the laws should be amended so that this kind of paper would bear interest, putting it in the marketable class of securities.

There seems to be a dark cloud in our special assessment law in regard to interest on the first installment where there are deferred installments. The ordinance usually sets forth that all installments except the first shall draw interest at the rate of 5 per cent., yet all municipalities collect the interest on the first as well as on successive installments.

Some municipalities issue vouchers on the first installment which bear no interest, but more of them issue those bearing interest. The former apparently have the law with them; the latter do it because they think it fair and honest, believing that as long as they collect the interest on the installment they should in turn pay it out on the voucher or bond. The special assessment law should be so amended that all installments shall bear interest and that all vouchers issued against the first or succeeding installments shall draw interest.

Summing up, an engineer's estimate, to be fair, conservative and reasonable, must be based on the following:

1. The actual cost of material and labor.

2. Contingent costs, amounting to from 10 to 15 per cent. of the above.

3. Contractor's profit, amounting to from 10 to 30 per cent. of the first two items. This will vary according to whether the contract is hazardous and difficult, requiring a large amount of special equipment, or whether it is comparatively easy, requiring but little equipment.

4. Allowance for converting the bonds into cash, amounting to at least 10 per cent. of the total amount of the contract.

C.P.R. TO USE FUEL OIL IN BRITISH COLUMBIA.

The chief engineer of the C.P.R. has investigated the cost and feasibility of using oil in the locomotives on the Cascade subdivision of the British Columbia division of the road with the result that, both in passenger and yard engines, oil tanks will be established at Vancouver, Coquitlam, Mission Junction and North Bend to supply the fuel for the locomotives. Oil has been used for fuel purposes for some time on the sections between Kamloops and Field, and also on some of the branch lines of the province. After the engines on the Cascade division have been changed and placed in commission it is intended to extend the plan to the section between North Bend and Kamloops, completing the change on the entire British Columbia division.

Fuel oil consists essentially of carbon and hydrogen, and the proportion of the latter is high enough to add materially to its heating power. It contains little or no oxygen to reduce the heat units obtainable from it, and it gives out much more heat, weight for weight, during its combustion than coal. Fuel oil also owes part of its superiority over coal in heating power to its greater freedom from moisture, ash and other agents. It is sufficiently accurate to regard the reducing effect of mineral matter, moisture, etc., on the heating power of coal as due to displacement of combustible matter. A coal containing 5 per cent. of ash and 5 per cent. of moisture would, so far as these constituents are concerned, contain only 9 lbs. of combustible matter in each 10 lbs. of coal. The ash and mineral matter in coals vary greatly. The moisture may rise to 10 per cent. and over, and ashes of 40 per cent. and over have been recorded. Fortunately these are excessive figures, and the proportions often run below 5 per cent. When the ash and moisture are low (and in some coals they may be as low as between 2 and 3 per cent.) the higher values for the heating power are possible. Fuel oil, however, is readily obtained free in a high degree from these constituents. The United States Government refuses consignments containing more than 2 per cent. of moisture, and insists on its being practically free from mineral matter. The higher proportions of carbon and hydrogen in fuel oil, and the practical absence of substances exerting a depressing effect on the heating power, explain the greater number of heat units obtained during the combustion of oil.

COST KEEPING IN COUNTY ROAD WORK.

In a paper read by Mr. R. P. Boyd, assistant state highway engineer of Alabama, at the annual meeting in January of the Alabama Association of Highway Engineers, the importance of cost keeping in all road work done by counties was emphasized, and the benefit that might be derived from an accurate system of cost keeping brought out. The following argument is presented:—

It is the engineer's duty to keep the cost of all work done by the county, and it should be one of his first duties to find out what work the county is doing is costing and to reduce that cost by engineering skill, good judgment and common sense.

A few engineers, some foremen and nearly all county commissioners object to cost keeping and the expense incurred.

It is unnecessary to argue here that an engineer on road work is necessary. But does the expense of cost keeping pay a county? Why does every business house go to the expense of keeping cost sheets and accounts and employ bookkeepers and auditors? Because it is absolutely necessary that that business know what each item of expense is and try to reduce the expense to a minimum. Why do the railroads keep the cost per ton-mile of each class of freight hauled? Why does the United States Government keep the cost per cubic yard of all classes of work done on the Panama Canal? Because these corporations and the government realize that they must know these small items of expense, which, if overlooked, soon amount to big sums. If this is true in business, why is it not true in county road work? Isn't that a form of business and shouldn't it be handled in a business way?

One of the first questions asked the Highway Department on going to a county, is: What will a road cost, or what will the grading cost? That same county has been doing road work since the county was established and does not know what its work is costing per cubic yard or per mile. Would you handle your own business in such a manner? How can you handle your road work in a businesslike way? Employ a competent engineer and demand that he show you results. If he can reduce the cost of your work to more than pay his salary the county has a good proposition and knows what it is doing.

For argument's sake, say that you have one outfit of ten teams working on the roads. Under ordinary conditions that outfit should move in grading from 200 to 300 cu. yds. per day, or an average of 250 cu. yds. Suppose that they work 20 days during the month, making 5,000 yds. moved for the month. Suppose that your engineer stakes out the work, cross-sections it and keeps the cost, and he finds it is costing 30 cents per cu. yd.—and we have found that in many counties it is costing that and more. If this is the case, something is wrong with the management of the outfit and the cost should be reduced. Contracts are being let all over the state for grading from 20 cents to 25 cents per cu. yd. Suppose the engineer can reduce the cost to 25 cents per cu. yd. In the one month you have saved on the outfit $250, and if there are more outfits the saving is increased. Can you afford to employ a competent engineer to make this saving?

Again, suppose that the engineer finds that the outfit is moving only 1,000 yds. of earth during the month, and under the conditions it should be moving 2,000. He knows that something is wrong and takes steps to correct it and by careful study finds the trouble and increases the output 1,000 yds. for the month, thereby reducing the cost to half.

The cost keeping is only one of the many duties of the engineer, but it is one that is often neglected in counties that have engineers. It is very easy to keep a system of cost accounts, and unless your engineer is on the job the entire time, the foreman must be required to keep the time.

Of course, on contract work it is necessary to know the cost of each item in order to make a fair settlement with the contractor, and no contract work should be undertaken without an engineer, for either the country or the contractor will lose by it.

The most complicated cost keeping arises when convicts are being used and it is desired to find the cost of different classes of work. The first thing necessary is to find the cost per day of each convict and each team. Suppose the outfit has only 30 convicts, 3 guards, 10 teams and a foreman. If these 30 convicts work 26 days during the month, then there are 780 convict days during the month. To find the cost per day, divide this 780 convict days into the total cost of all convicts, including supervision, guarding, feeding, clothing, medical attention and every item of cost. Suppose this amounts to $273 for the month, then the cost per day per convict is 35 cents. In the same way we find that the teams have cost, say, $390, or $1.50 per day. Now, if the foreman keeps on his time sheet or book what each man and team is doing and turns it over to the engineer, it is an easy matter to figure the cost of each class of work. For instance, suppose 10 teams and 15 men are working on a fill for three days. The cost of that fill would be:

$$
\begin{aligned}
15 \times .35 \times 3 &= \$15.75 \\
10 \times 1.50 \times 3 &= 45.00 \\
\hline
\text{Total,} \quad & \$60.75
\end{aligned}
$$

If the fill contains 400 cu. yds., then the cost per yard is 15.18 cents. These figures are assumed. Some actual cost data on convicts taken from a state aid road in Bullock County are: Cost of maintenance of convicts per day, 39.2 cents; cost of teams per day, $1.29. At this rate the grading cost 15.2 cents and sand-clay cost 15.3 cents per cu. yd.

Occasionally you find a foreman who rebels at keeping these cost items, but generally that man is afraid to know what his work is costing and he is not honest with himself or the county. In most cases the foreman is glad to find what the cost is, and tries to improve his work and his own efficiency as a foreman.

These figures are not mythical or hearsay, but are tried and proven facts. Think of what your county is doing and try to better road conditions. And the first step is to get an engineer, and the next to keep cost accounts.

A definite announcement has been published to the effect that the Northern Navigation Co., one of the most important corporations operating in Alaskan waters, has sold its steamers, barges and terminal facilities to the American Yukon Navigation Co., and the latter will continue to transact the transportation business to all points on Yukon River and its tributaries. The Northern Navigation Co., which was controlled in San Francisco, operated 43 steamers and 54 barges, and owned terminal facilities in Alaska. The American Yukon Navigation Co. is stated to be backed largely by English capital, and to be a part of a big organization which includes the White Pass and Yukon Route owning and operating the railway from Skagway to Whitehorse and steamers and winter stage lines thence to Dawson.

NEW BRIDGE AT PORT COQUITLAM.

As announced in the Construction News columns of May 14th issue, a new bridge is to be erected by the Department of Public Works of British Columbia over the Pitt River, at Port Coquitlam, about 20 miles east of Vancouver. It will be located about 400 yards above the Pitt River bridge of the Canadian Pacific Railway, the substructure of which was described in *The Canadian Engineer* for June 19th, 1913.

The proposed bridge will have timber trestle approaches 540 ft. and 270 ft. at the west and east ends respectively. The bridge proper will rest upon 9 concrete piers, constructed upon timber cribs, the two outer piers being protected by timber piling. At this point borings have indicated a light clay and mud river bed, for a depth of approximately 150 ft. The maximum depth of water at high tide is about 56 ft. and at low tide 50 ft.

The superstructure is to consist of 7 spans which formed a part of the bridge purchased from the Canadian Pacific Railway Company, this bridge being the one that has just been replaced by the new double track bridge described in the article referred to above. It is a single-track construction and has been in use approximately six years. The entire bridge was purchased intact for the sum of approximately $70,000.

The swing span is designed to give a clear opening of 93 ft. on either side of the pivot pier. It will have a clearance of 24 ft., while the trestle approaches will be 24 ft. in width. The deck of the bridge will be so constructed as to provide for electric railway tracks if necessary at some future time.

The portions of the bridge for which tenders are now being called are the complete substructure, including guide piers and trestle approaches. The contract for the transfer of the Canadian Pacific Railway bridge to its new site was let some little time ago.

The estimate of cost for the construction of the complete bridge is $450,000.

The distance of a sea mile varies in different parts of the globe. At the Equator a knot would be 6,045.95 feet; at the Poles it would be 6,107.76 feet, and in the latitude of the ocean route from Europe to New York about 6,080 feet. Nautical surveyors take into account these small differences, and the measured nautical mile for speed trials on the Clyde, where the Lusitania was built, is longer than the nautical mile used for the same purposes more southerly. The British Admiralty knot is 6,080 feet, and the recognized knot of the United States Navy 6,080.27 feet. A knot in very general use measures 1,000 fathoms, and a fathom being 6 feet, this knot would be 6,000 feet.

In *Stahl and Eisen*, attention was recently drawn to the fact, by A. Müller of Gutehoffnungshütte, that a Girod furnace has been running for 4 years, without interruption, at the Gutehoffnungshütte Works. He claims in contrast to many early assertions that this type of furnace is distinguished by great durability of the hearth and simplicity of construction; and that the furnace has behaved admirably in practice. The advantages of the Girod electric-arc furnace are that in melting down cold charges it also works as a resistance furnace, in consequence of the passage of the current through the whole mass of scrap, and is of undeniable value as regards the rapid melting down of the charge, especially at the beginning of the smelting process. The slow and continuous leaping of the numerous arcs from particle to particle of scrap proceeds very quietly and without producing any appreciable rushes of current, the result being that the electrodes can be regulated automatically during the [illegible] operation goes on very smoothly and in conjunction with the uniformity of current distribution and generation of heat on the steel bath, and also the low tension at the poles, the difficulties of insulation are diminished.

TOWN-PLANNING CONVENTION IN CALGARY.

THE Alberta Town Planning and Housing Association will hold a convention in Calgary, June 16th, 17th and 18th. Invitations have been issued to municipalities and interested organizations throughout Canada. In connection with the convention, a city-planning exhibition will be held, the various exhibits of which will, in general, come under the following heads:

Railways.—Railway stations; railway bridges; plans of railway elevation, or depression; street railway systems; city and radial railways; street railway "fare" zones, if any.

Transportation (and Streets).—Bridges, civic and other; views of principal streets; parked streets; street plans; street planning.

Population.—Maps showing increase in area, by annexation, each increment to be distinguished by shading or color; maps showing density of population; plans showing present and prospective development; plans showing railway lines and industrial sections; factories, kind of, and factory districts.

Water Supply.—Reservoirs; stand-pipes, artistic and the reverse; pumping stations.

Sewers.—Plans showing lines of sewers; cross-section, etc., of principal sewers; sewage disposal plant.

Fire Protection.—Fire-swept areas, plans and photographs; high-pressure and low-pressure systems.

Parks and Squares.—Views in parks; parks at street intersections; maps of park systems, existing and proposed; swimming baths; monuments.

Housing.—Model houses; model subdivisions; tenements, illustrations, plans, costs and rentals; playground scenes; schools; municipal buildings, post offices, custom houses, museums, university buildings, etc.; public libraries; public markets.

Smoke investigations, and water-falls.

A feature of the convention will be the consideration of a proposed housing bill for the province of Alberta. The civic plans for Calgary and other cities of the Dominion will be on exhibition. His Honor Lieut.Governor G. H. Bulyea will begin the proceedings and various ministers of the government will take part in the deliberations. Mr. T. T. John, City Hall, Calgary, is Secretary-Treasurer of the Association.

At Nelson, B.C., a local syndicate has been formed to carry on placer-mining on Forty-Nine creek, a few miles west of Nelson, and lumber for a flume has been ordered. It is stated that the syndicate has obtained control of placer leases covering 4 miles of ground on the creek. In early years placer-miners worked successfully on the creek and obtained gold to a considerable total value.

Concerning mining in Saskatchewan, it has been reported that at Prince Albert, approximately 500 mineral claims had been staked by the middle of April at Beaver Lake since public attention was several months ago turned to that part of the province as a promising field for gold. On Saturday, April 11, registrations of 104 locations of claims were made at the Dominion Land office there, which constituted a record for any one day, but there has lately been such a rush to the new field that it is expected this will be surpassed.

A syndicate, recently incorporated under the name of the Vancouver Oil and Natural Gas Company, is carrying on careful and thorough prospecting of the oil possibilities in the flat district around Pitt River, B.C. Extending from the southern end of Pitt Lake, through towards Port Haney, they have thousands of acres of land under oil lease from the Government. Several other companies are prospecting in the Fraser delta, and quite a showing of oil indications is said to have been met with in Hatzic, further up the Fraser River from Mission, B.C.

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THE MONTREAL ROAD CONGRESS

Road building in Quebec and Ontario was given an impetus by the First Canadian and International Good Roads Congress held in Montreal last week. Unfortunately, there were less than a score of delegates in attendance from other provinces, but the interest shown by Ontario and Quebec was manifested by an attendance of sixty-seven men from Ontario and one hundred and sixty-six from Quebec Province outside of Montreal. There were registered at the Congress one hundred and seventy-two residents of Montreal. Thirty speakers, visitors and guests came from the United States.

The Congress had the official support of the Quebec Government, being attended by the Lieutenant-Governor, the Premier, the Minister of Roads and the Deputy Minister of Roads. Many interesting announcements were made by these officials, including the fact that another ten million dollars will be voted by the Quebec legislature to lend to municipalities for road construction, the ten million dollars which was previously voted, having been practically all expended.

Hon. Louis Coderre, Secretary of State, represented the Dominion Government at the Congress, and promised that Federal aid to good roads would soon be available upon terms which he thought would be acceptable to the provinces. At the banquet Hon. Mr. Coderre and Hon. Mr. Tessier, Minister of Roads for the Province of Quebec, announced the construction of various roads and bridges amidst enthusiastic cheers.

The announcement made by Hon. Mr. Tessier that the municipalities of the Province of Quebec now owned one hundred and fifty complete road outfits occasioned considerable surprise as, so far as is known, most of these outfits were purchased without public calls for tenders.

A prominent official of the Quebec Government voiced the hope to *The Canadian Engineer* that slightly different methods will be used in the spending of the next ten million dollars to be voted by his Government. Instead of a municipality that had, say, thirty thousand dollars of money borrowed from the Government to be expended on roads, paying six or seven thousand dollars for a road outfit, and then having the roads constructed by a newly organized gang, this official urged the letting of these contracts to experienced road contractors who own their own plant.

A permanent organization of the Congress has been effected with W. A. MacLean, of Toronto, as president, to make the Congress an annual affair. Therefore, the voicing of a suggestion or two as the result of close observation of the proceedings at Montreal might be appropriate.

The Canadian Engineer has nothing but praise for the efficient work done by the executive committee of the Montreal Congress. There was nothing to be improved upon in regard to the handling of the exhibits, but the business sessions or papers of the Congress appeared, to technically trained men, to lack effectiveness in some particulars. A brief period of discussion should be provided for at the termination of each paper. There is probably always an interested listener who desires to obtain further light upon some portion of the treatment of a subject, or who has valuable opinions to express. With the session commencing at 3 p.m., however, and with seven or eight papers of varying lengths to be disposed of during the remainder of the afternoon, there is no opportunity for discussion, nor even for the speakers' best treatment of their subjects. The addition of a morning session and a

reduction by half in the number of papers for any session, would allow time for discussions.

There was some objection at Montreal to a few papers against which the charge of "commercialism" was laid. Some delegates thought that the speakers had taken advantage of the opportunity to present the methods of their particular type of pavement in an unnecessarily forcible manner. Municipal and highway engineers and road contractors, however, would not object to these papers, as much was to be learned from them. No man is so likely to be able to give valuable and comprehensive data regarding a pavement as the manufacturer of that pavement. There are only two possible objections to the so-called commercial papers: First, the possibility of unfair play by permitting a few types of pavement to be so presented while equal opportunity is not given to other types; secondly, the lack of time for an open discussion of the papers after they are presented, so that by argument and counter-argument between the manufacturers, engineers, road contractors and others who have experience in regard to the pavements, the merits and demerits of the respective pavements could be established.

From a technical standpoint, far more work would be accomplished by such a Congress were every paper to be printed and distributed about two weeks previous to the Congress, and the papers taken as read instead of being actually delivered. The entire time could then be given over to discussions and to the answering of questions by the authors of the papers. Of course, certain rules of debate, such as time limits, would be necessary, but the data that would be brought out in this way would be most valuable.

The Congress owes a vote of thanks to the American speakers who gave their time to assist the cause in Canada. Half of the speakers were guests from the United States. It is to be hoped that next year's Congress will see more Canadian engineers and officials accept the invitation to prepare papers, so as to get the benefit of their experience regarding climatic and other conditions peculiar to Canada.

STREET CLEANING AND ITS IMPORTANCE.

Many of our cities have awakened to the realization that spring house-cleaning is as much a necessity for the community as for the individual housekeeper. There appears to be a widespread appreciation in our cities that cleanliness and health go hand in hand and some are entering into the work with commendable zeal. The cleaning-up process has outgrown in numerous instances its magnitude of a few years ago, with the result that such operations cannot be carried out to civic satisfaction in a single day. The result is "clean-up week," such as the City of Montreal held during the week of May 18th.

The purity of the public water supply is generally recognized as a necessity in the promotion of public health. The same applies to the food supply, and, as is evident in cities large and small, the importance of providing a pure air supply for the community is such as to warrant continual effort in the matter of proper cleaning of streets and lanes. These become soiled and dirty as a result of, and in proportion to, their use. The materials gather thereon, partly due to carelessness, but are partly the result of conditions beyond control. They harbor large numbers of bacteria, of the nature of which little is known. While disease-producing organisms probably do not exist for long periods of time on our streets, they may be present and may thus become direct causes of infection. When dry, the material lends itself to transportation by currents of air, thus entering offices and homes, discoloring buildings and lawns, and generally affecting atmospheric conditions even to the extent of irritating the respiratory organs of citizens.

The problem of maintaining the streets of a city in a clean and healthful condition has been given considerable study in the principal European cities. The average city in this country, however, has not adequately recognized the importance of it and the work of the street cleaning department has not progressed to a careful study to determine the most efficient and economical methods of street cleaning and the nature of the results thereby obtained. The street cleaning department is not considered one of such importance as to necessitate the care and supervision of a trained expert, and where such a department exists it is generally under the direction of a man who knows little or nothing about sanitary science. The results to be expected are lack of system, inefficiency, unsightliness and danger to health.

Mr. W. H. Dittoe, chief engineer of the Ohio State Board of Health, has made a study of the methods usually followed in the cleaning of city streets and the manner in which they differ in various cities. He has stated that his investigations appear to show that the experiences of other cities are seldom taken into account. In those cities where the greatest advance has been made water is used as an adjunct, if not as a principal means of removing the material.

"The early methods of cleaning streets," states Mr. Dittoe, "utilized the machine broom, a horse-drawn vehicle with a cylindrical brush which in rotating throws the material toward the gutter. The use of this machine is often accompanied by the production of clouds of dust and the cleaned surface is not freed of the fine particles which adhere to the pavement, later to be transported by the wind. This method has been discarded in the most progressive cities in favor of more proper and advanced methods. It is now generally conceded that a street can be properly cleaned only by washing with water. Numerous devices have been proposed for the application of water to the surface of the street and all have their peculiar advantages. The European cities utilize a hose for street flushing. In the principal American cities a flushing machine is used by the operation of which the water is applied from a tank wagon under a pressure sufficient to remove the dirt from the surface. A somewhat more recent device is the combination sprinkler and squeegee machine. In the operation of this machine, the water is first applied to the surface and shortly after the wetted material is removed by a rotating cylinder fitted with rubber squeegees set spirally. The action is similar to that which takes place in the washing and drying of a window. These machines have been adopted in a number of American cities. In Berlin, Germany, an attempt has been made to utilize a vacuum machine similar in its principles to the machine almost universally used for the cleaning of carpets. This machine has not been tried out a sufficient length of time to determine its merit but it offers a method of removal of waste materials entirely satisfactory in its sanitary aspects. In general, it may be said that while marked advance in methods of street cleaning have taken place during the past few years, considerable study remains to determine the most efficient and economic methods to be used."

TECHNICAL TRAINING FOR HIGHWAY ENGINEERS.*

By A. T. Laing, B.A.Sc.,
Professor, Faculty Applied Science and Engineering, University of Toronto.

IN dealing with questions of debate one is more or less liable to be hampered with certain prejudices. The old adage that to err is human is perhaps equally clearly expressed if we say that to have a prejudice is human, and the extent to which we are so hampered is a measure of our liability to be led astray.

Coming as the writer does from an educational institution it might be supposed that he was prejudiced in a desire to promote the employment of young graduates, but while indulging a legitimate desire to give such assistance whenever possible he holds no such brief on this occasion.

Primarily the motive of the writer is to show the sympathy of the University of Toronto with this movement and to tell you something of the contributions it is making, and secondly to show a personal interest in the convention, at the same time placing some emphasis on features which he believes have an important bearing on the aims of this meeting.

Let us look briefly at what the aims are, of a course of technical training for engineers. It should greatly extend his horizon, instil a spirit of inquiry, suspend prejudice, enable him to approach a question with a clear and analytical mind. It should give him an increased sense of responsibility and more highly fit him for "the art of directing the great sources of power in nature for the use and convenience of man." A student of average endowments who has taken advantage of the instruction of an approved curriculum has been given a mental equipment which he might otherwise never acquire, and the institution which gave the instruction has been at least in a measure successful. Let us not forget, however, that there is one thing that has not yet been accomplished, the young man has not been made an engineer. That is above the might of an institution and should never be confused with its aims.

The technical graduate has only been given a start and if he is ever to become an engineer it must be through subsequent experience.

What, then, are the functions of the man thus equipped with the mental training and the subsequent experience? In brief it is the complete investigation of a given problem and with the conditions as he finds them to arrive at a solution. In other words, he must diagnose the case and prescribe the remedy, the difference between the engineer and the physician being that in many instances the filling of the prescription is the most costly part, and further, there is no specific remedy, the means employed must be governed by local conditions, and this is precisely what engineering means, the providing of one thing in one case and another thing in another to bridge over the exact same difficulty. Were it not so, all engineering problems might be reduced to a mere set of rules and all we would need would be skilled workmen to put them into execution.

Let us now see what bearing this has on the road problem. There is possibly no branch of engineering work in which a wider variety of conditions may be found. In many instances the problems demanding solution are such as to require the highest skill and experience and the conditions may alter many times in every mile of length. Among his duties might be mentioned the following:

1st. To make a survey of the road, to make profiles, establish grades, provide drainage and to relocate where necessary to avoid cuts and fills.

2nd. Prepare plans and specifications for the construction of the road and for all bridges and culverts, making ample provision for the areas to be drained.

3rd. He should be able to direct the work, provide thorough inspection, keep records of progress and all costs.

4th. He should know his machinery, its capacity, when it should be repaired, in fact mechanical appliances are employed to such an extent that he should be a mechanical engineer.

Reviewing briefly the history of road work, what do we find as touching the employment of engineers? If we go back to the time of the Romans it is not doing them an injustice to say that with all their engineering skill displayed in other works, the remarkable roads which they built were utterly lacking in the principles of sound engineering. The fact that they were able to disregard economy could scarcely be taken as an explanation for the enormous amount of labor involved in the construction of their Royal roads. There was an absence of the spirit of inquiry. They built well, but not wisely.

During the dark ages which followed the Roman period, very little road work was done. The revival of road building in France during the early part of the eighteenth century although a modification of the Roman method was marked by the introduction of more scientific principles and certainly of economy. This work was followed by that of Tresagnet, and later by Macadam and Telford and others, men of outstanding engineering ability who were among the first to employ scientific principles in the solution of the road problems of the day. Of the success of their achievements it is unnecessary to speak. The attention given to drainage, location, gradients, uniformity of cross-section, the construction of bridges, etc., were all high tributes to their engineering skill. And so with subsequent movements in road improvement we find that they have been headed by leaders in the engineering profession.

We see, therefore, the part that has been taken by technical men in the past, but where do we find ourselves in Canada to-day? There is one point at least in which we resemble the Romans, our efforts have lacked in sound engineering principles but alas the contrast—we have no roads while the Romans had. We are now on the verge of a movement which is bound to do more for our national development than all our railroads are doing. The railroads have developed the large commercial centres but they cannot supply the need of our highways. To this movement our technical institutions must contribute their share.

The place that is given to technical training in Europe will be of interest; France holds the leading place in all Europe in matters pertaining to roads. The military operations of Napoleon gave great impetus to the movement as it materially aided in the mobilization of troops. The work was recognized of such importance that it led to the creation of the Department of Roads and Bridges, which department continues to the present, and under the Minister of Public Works it has the direction of a comprehensive national road policy which has made France famous in this respect. And what do we find as an outgrowth? Recognizing the importance of trained men for the work, the School of Roads and Bridges was

*Read at First Canadian and International Good Roads Congress, held at Montreal, May 18th, 1914.

established and while the curriculum is designed to give instruction in other branches of engineering, the object for which it was designed and the outstanding feature, as name would imply, is the technical training of men for positions on staff of highway engineers.

The young men desiring to qualify for service in the department are required to take a short technical course where mathematics and science make up the major part of the work. From this they pass on to the School of Roads and Bridges and receive a three-year course of instruction in civil engineering. The vacation periods are for the greater part spent in the field under the department. It will be seen, therefore, that a very thorough course of theoretical and practical training is established.

As to the justification of the establishment of this institution one need only point to the splendid system of highways which extend throughout the republic. This influence of France in this respect has been felt in the other countries on the continent, Germany, Switzerland, Italy and others have profited by her experience, and while organization in these countries has not reached the same degree of perfection, great stress is laid on both the practical experience and the technical training of men seeking appointment as highway engineers.

In Great Britain a very different system is followed. There are many instances in which surveyors are appointed who have not had technical training, but this practice is not working out satisfactorily and the tendency now is to lay greater stress upon thorough technical training. The apprenticeship system is in vogue and the long and tedious training through which the pupil has to pass is surrounded by numerous limitations. A young lad with ordinary schooling articles to a county or municipal engineer for a period of three or four years. By hard work and study during this time he may pass the preliminary of the professional examinations and at the close of his pupilage he is qualified for appointment as an assistant and so he works his way up by stages to a chief appointment. It will be seen that by this method no standard of excellence is set, although his membership in the various professional associations will help in this respect. Furthermore, the duties of his chief may have been such that the pupil gained very little insight into road construction and management, and in the nature of the case the knowledge of the subject gained must be limited to the field within which his experience lay.

The consensus of opinion, however, is in favor of a thorough technical training and a recognition of its importance is given in the fact that a student with an engineering training may reduce the period of pupilage to one year.

Coming to this continent, what do we find? Alas in the past there has been little disposition to recognize the office of a highway engineer. An assumption far too common has been that anybody can build roads, and what is the result? Either that illusive personage has given up the job or he has been bluffing, for we are still, in a large measure, without roads.

In both Canada and the United States many municipalities have paid heavily to prove that the township clerk, or the assessor or some other official could not build a culvert, a concrete bridge abutment or a road that would last, and many a lamentation has gone up that enough money has been spent to have paved the road in gold and still the road is bad. It is true that engineers, even the best of them, at times may make mistakes, but it is safe to say that their achievements in other lines is sufficient to warrant the recognition of their services in the solution of the problems in highway work.

With the changes that have been brought about in recent years through the introduction of the motor-driven vehicle the problems have become more complex and our treatment of the question has not kept pace with the demand, due largely to a disinclination to abandon old methods.

That the universities of this continent are not lax in dealing with this question may be seen by a brief review of what is being done. In the United States remarkable advancement has been made. In nearly every technical institution where a course of civil engineering is taught the subject of highway engineering is given a prominent place, and in many cases is made a major subject of the final year. Five years ago less than half of these institutions touched the subject. The Department of Public Roads at Washington, through the efficient directorship of Logan Waller Page, has also given a great impetus to the training of young men. By giving a special course of instruction in the department and then placing these men in charge of work on the field a practical demonstration has been given of the value of such training.

In Canada, we are glad to see that a like recognition of the subject is being given. It is not possible, at this time, to go into details but we are pleased to note that highway engineering is given a prominent place in the curricula of nearly all the universities and technical colleges throughout the Dominion. In this, Laval University has been the leader, having begun such a course over twenty years ago. In the University of Toronto the subject is combined with sanitary engineering in the fourth year of the civil engineering course. The time is devoted to a lecture and reading course dealing with the design, drainage, foundation and the construction of all types of roads from the ordinary clay road up to high-class city pavements. A lecture course on the geology of road metals, a lecture course on municipal structures, including highway bridges, culverts, retaining walls, etc., a laboratory course for the examination of the properties of sands, gravels and the various kinds of rock employed in road construction and also for the physical properties of bituminous materials, all of which have a direct bearing upon the efficiency of the young engineer.

One feature of this work is worthy of special mention. Laboratory investigations will continue to form an important adjunct to our highway work and it is of utmost importance that the engineer in charge of work should know how to interpret such reports and there is no way in which he can do this more intelligently than by having conducted a series of experiments himself.

In view of the facts cited with respect to practice followed in Europe, what should be our attitude in Canada? Can we afford to disregard the features in training to which they in Europe give such prominence? Certainly in many respects our problems are beset with conditions more difficult and such as tax to the resources of our best engineering skill and ability, and this congress will have conferred a lasting benefit on our community if it does nothing more than to educate public opinion to a fuller recognition of the importance of utilizing the services of our technically trained young men in the improvement of our highways.

This is mentioned as one feature of our pressing needs, not unmindful of the fact that there are others. As much more might be said regarding a systematized national policy, but even this must be organized and put into execution by engineers who can fully grasp the problem. His status must be recognized and the rewards for his services commensurate with the high office he is called on to fill.

ROAD CONGRESS AT MONTREAL.

THE First Canadian International Good Roads Congress was held in Montreal last week. It was marked by the attendance of a goodly number of men whose prominence in road matters in Canada and the United States is well known, their presence serving as an indication of their optimistic feeling and their eagerness to be of assistance on this particular occasion. The Good Roads Show was well patronized and the entire arrangement was such as to provide every delegate with an opportunity of taking full advantage of the entire proceedings of the convention.

The opening session on Monday afternoon was largely devoted to inaugural addresses. Mr. U. H. Dandurand, chairman, in his opening remarks, bore out the good and substantial aims upon which the Congress has been founded. Sir Francois Langelier, Lieut-Governor of Quebec, and Sir Lomer Gouin, Premier of Quebec, attended this opening session and took part in the ceremonial speeches. The former outlined the condition of the roads in Quebec as it was many years ago, and traced the development of the idea that good roads were a necessity from the time when the people in Quebec Province looked only to the St. Lawrence River and other great water routes, as well as to the snow roads of winter, for their means of transportation. The Premier spoke of the aims of the Province of Quebec in the matter of good roads, and indicated that a very substantial progress was being made. They had spent seven or eight millions of dollars on roads and had some exceedingly good roads to show for it.

Hon. Louis Coderre, Secretary of State, voiced the hope that the Federal and Provincial governments would come to an early arrangement respecting a grant for road construction and improvement.

The next address was that of Mr. W. A. McLean, Provincial Highway Engineer for the Province of Ontario, and president of the American Road Builders' Association. Mr. McLean spoke on highway legislation. In this connection he maintained, as principles of highway legislation that could have a general application, that cities should assist in the payment occasioned by the building of public highways; that municipal self-administration should be encouraged, and that the central administration should be relied upon for assistance when circumstances demanded.

Dr. E. M. Desaulmiers, M.L.A., Chambly County, St. Lambert, P.Q., spoke briefly concerning road legislation for the Province of Quebec compared with other provinces.

Mr. A. N. Johnson, chief state highway engineer of Illinois, presented a very interesting paper entitled "Planning of System of Public Roads," but owing to the lateness of the hour Mr. Johnson was obliged to follow the example of the previous speaker by reading only brief portions of his address. His chief contention was that the first necessity in road construction was to make a plan of the work to be done over a wide area, so that in future years whatever work was done they would be working on the recognized system which, when completed, would be twice as valuable on account of its unity.

In the evening and on other evenings throughout the convention special illustrated lectures were given by the manufacturers of road-building materials and machinery, represented at the Congress. They were well attended and displayed many interesting features in the solution of problems commonly met with.

The next session of the Congress took place on Tuesday afternoon. In his opening address, Mr. Dandurand reviewed the work of the previous day. He introduced the subject of a permanent organization. Later in the afternoon he brought the subject again before the meeting, putting it in the form of a motion, which was unanimously carried. The following committee was appointed to make a report to the Congress: Mr. Geo. A. McNamee, secretary-treasurer of the Good Roads Congress; Mr. W. G. Robertson, secretary of the Canadian Automobile Federation; Mr. I. S. Pennybacker, secretary of the American Highways Association, and Mr. H. W. Pillow, president of the Automobile Club of Canada.

In an address entitled "Important Considerations Entering Into the Selection of Pavements for Roads and Streets," Mr. W. H. Connell, chief of Bureau of Highways, Department of Public Works, Philadelphia, emphasized the necessity for trained men for the construction and maintenance of highways. Enormous sums of money had been uselessly expended by those who employed untrained men not only to construct but to maintain their roads. Next in importance to the personnel, careful consideration should be given to the drainage, the present and probable future traffic, foundation gradient, social and sanitary conditions, and wearing surface. Rigid inspection of a road in the process of construction was an absolute necessity.

Mr. E. A. James, consulting engineer to the York County Highway Commission, presented a paper, read by Mr. W. Huber, of the Ontario Department of Public Works, on "Maintaining Macadam Roads." It was claimed that nine-tenths of the objections to macadam roads arose from an improper observation of the rules which govern their maintenance, rather than from difficulties of construction. A list of the various agencies tending to deteriorate such roads was given prominence among which were mentioned narrow tires. The paper favored the patrol system of maintenance and expressed both the statute labor and the contract labor systems of maintenance as generally satisfactory.

"Points Worth Knowing in Connection with Road Improvement," was the subject dwelt upon by Major W. W. Crosby, consulting engineer, Baltimore. Any comprehensive scheme, according to the speaker, necessitated the selection of the most important roads and also the selection of methods and means to be employed. The construction of good roads should be regarded as an investment which must show both direct and indirect benefits. Borrowed money should be used entirely for construction purposes, and the cost of maintenance should be guaranteed out of annual levies. Major Crosby emphasized the fact that there was no such thing as a permanent road. Every road requires maintenance and careful attention, no matter of what type it may be constructed.

Lieut.-Col. W. N. Ponton, honorary president of the Ontario Associative Boards of Trade, read a most interesting paper on good roads as a factor in the progress of cities and towns. The speaker did not endeavor to present anything in the nature of a technical paper, but his address was a rousing elucidation of the effect upon the country which is sure to follow the establishment and proper maintenance of good roads. He suggested that the Congress should be made a constant and permanent element of influence and that it should appoint a committee to lay before Parliament a well-digested plan for accomplishing the best work by the best methods.

Mr. R. Lehmann, engineer of the French Government Service, New York City, gave a very interesting address

in French on the administrative organization by which French roads are constructed and maintained. As numerous references had previously been made to the excellent roads in France, the observations of Mr. Lehmann were followed with close attention.

On Tuesday evening a banquet in honor of the guests of the Congress was held at the Hotel Windsor, and was attended by approximately 100 delegates. The speeches were such as to arouse enthusiasm in the building of roads, while several announcements of importance were made pertaining to appropriations in Quebec for the same.

On Wednesday morning tours of investigation were held whereby the delegates had an opportunity of seeing for themselves roads and streets in and around Montreal and the adjoining towns.

At the Wednesday afternoon session Mr. C. L. Shorey, of Beaconsfield, P.Q., began the proceedings by a brief talk on road improvement in that town.

"Concrete Roads and Streets" was the subject of a paper by Mr. L. R. Ferguson, assistant secretary, Association of American Portland Cement manufacturers, Philadelphia.

Mr. Ferguson's paper dealt largely with the cost of construction of cement roads as compared with that of other types, and dwelt upon the relative costs of maintenance. He spoke of the burdening of municipalities to the extent of $650 to $1,000 per mile per annum in the case of several types, whereas the cost of maintenance of the cement roads was placed by him at from $25 to $50 per mile per annum.

When the bonds matured, the latter road still remained in good condition, whereas other roads were frequently found to require replacing before the expiration of the usual 20 years. Another advantage voiced was the low crown of the concrete roads which reduced the danger from side-slipping, thereby being a distinct advantage both to horse and automobile traffic.

Professor Arthur H. Blanchard, of the Department of Highway Engineering of Columbia University, New York, gave an illustrated talk on modern bituminous surfaces and bituminous pavements. He dealt to considerable length with the construction of such roads and the improvements which the practice of later years have presented. Various types of machinery were illustrated and the most satisfactory methods of construction and maintenance clearly outlined. Professor Blanchard showed a number of interesting views of roads and road work in America, and in England, France and Germany.

Mr. A. T. Laing, of the Department of Highway Engineering in the University of Toronto, read a paper entitled "Technical Training for Highway Engineers," in which was clearly brought out the value to the road movement which would accrue from the courses of instruction that were being given at the principal universities and colleges throughout the Dominion.

"Road Designing" was the subject of a paper by Mr. R. A. Meeker, engineer, Department of Public Works for the state of New Jersey. In the course of his paper he emphasized the importance of selecting the best route and also the importance of proper grading. Mr. Meeker reiterated the words of the prophet Isaiah who, over 2,600 years ago wrote, "Every valley shall be exalted and every mountain and hill shall be made low, and the crooked shall be made straight and the rough places even."

Mr. Will P. Blair, secretary, National Paving Brick Manufacturers' Association, read the next paper, which was entitled "The Economy of the Brick Highway." Mr. Blair based his remarks upon the value of making careful comparisons with respect to the relative merits of paving material and outlined the elements in the economy of the road and the relation which they bear to each other.

"The Relation of the Technical Press to the Good Roads Movement," was commented upon by Mr. H. Irwin, editor of *The Canadian Engineer*. His paper dealt with the classification of the engineering literature at the service of the man associated with road administration and development. Respecting the selection of technical books on road work, he emphasized the value of dependence upon unprejudiced and straightforward reviews which are to be found in the recognized technical journals published from time to time. He outlined the growth of engineering literature on the subject of roads and suggested a plan whereby the road man could equip himself with a valuable library of information upon his subject. He strongly emphasized the value of the card index system in the preservation of articles of interest. The road man was warned against limiting the scope of his reading to that which pertained only to his immediate needs. It was claimed that the successful road engineer should read much more than that which deals with his own special work.

At Thursday's session Mr. O. Hezzelwood, chairman of the Canadian Automobile Federation, presented the first paper, which was entitled "The Relation of the Motorist to the Good Roads Movement." Following him, Mr. H. W. Pillow, president of the Automobile Club of Canada, made some observations and some valuable suggestions regarding the road movement.

The secretary of the American Society of Engineers, Architects and Constructors, Mr. T. Hugh Boorman, presented a paper entitled "Modern Road Construction in the United States and England." Mr. Jean De Pulligny, chief engineer, bridges and roads and the director of the French Mission of Engineers to the United States, spoke concerning the International Good Roads Congress, while Mr. J. W. Levesque, of Montreal, gave an address entitled "The Improvement of Rural Roads as a Source of Considerable Economy to the Farmer.

Another paper, entitled "Automobile Organization and Harbor Improvement," was read by Mr. W. G. Robertson, secretary, Ontario Motor League.

Mr. H. M. Capron, of Chicago, addressed the Convention on the subject of the bulk handling of cement.

Mr. Lucius E. Allen, consulting engineer, Belleville, Ont., read the last paper of the session, entitled "The Construction of Modern Highway Bridges."

Toward the close of the Congress the committee which had been appointed a few days before to make a report respecting a permanent organization, brought in their report, which was received and unanimously adopted. The officers elected were: Honorary President, A. U. Dandurand, Montreal; President, W. A. McLean, Toronto; First Vice-President, D. Michaud, Quebec; Second Vice-President, O. Hezzelwood, Toronto; and Secretary, G. A. McNamee, Montreal. Directors: H. W. Pillow, Montreal; W. J. Kerr, Vancouver; Col. W. N. Ponton, Belleville; Ald. R. J. Shore, Winnipeg; R. S. Henderson, Winnipeg, and J. Duschatel, Outremont, Que.

The list of directors has been left incomplete in order that the present executive may add to their numbers representative men from all parts of the Dominion.

Among the delegates who attended the convention from the United States were the following: J. S. Barron, Baker & Barron, New York; Col. T. H. Boorman, secretary American Society of Engineers, Architects and Con-

structors, New York; C. C. Blair, Youngstown, Ohio; Prof. A. H. Blanchard, Columbia University, New York City; A. G. Batchelder, New York; M. M. Campbell, C.E., American Road Building Association, New York; Major W. W. Crosby, Baltimore, M.D.; W. H. Connell, Philadelphia, Pa.; J. R. Draney, General Sales Manager, United States Asphalt Refinery Co.; W. DeWind, Austin Mfg. Co., Chicago, Ill.; A. N. Johnson, Chief State Highway Engineer, Springfield, Ill.; R. Lehmann, Engineer of French Government Service, New York; R. A. Meeker, State Highway Engineer, Plumfield, N.J.; A. F. Masury, New York; I. S. Pennybacker, Washington, D.C.; M. D. Powers, New York; E. S. Powers, New York; O. R. Parry, New York; Wm. A. Perkins, Connsant, Ohio; H. K. Salmon, Netcong, N.J.; Gordon Smith, Albany, N.Y.; H. Spencer, New York; Geo. D. Steele, Germantown, Pa.; H. C. Tattersall, The Troy Wagon Works Co., Troy, Ohio, care Wm. McNally & Co., and Maurice R. Young, New Jersey, Robeson Process Co.

Four hundred and fifty delegates, guests, speakers, exhibitors, etc., registered at the Congress. Of these, one hundred and seventy-two were from Montreal and one hundred and sixty-six from Quebec Province, outside of Montreal. One hundred and twelve registered from without the Province of Quebec, these being divided as follows: Ontario, sixty-seven; New Brunswick, seven; Manitoba, four; Alberta, two; Nova Scotia, two; India, one; United States, twenty-nine.

The exhibition of road machinery and materials which was held in connection with the Congress was very well managed and made a good impression upon those in attendance. It compared very favorably indeed with any similar exhibition that has ever before been held in every respect, excepting, of course, in the number of exhibits. Not only was the exhibition very pleasing to the eye, but to those who took the time to study carefully the machinery and materials presented and to listen to the information given by those in attendance at the booths, there was much to be learned.

Asphalt and asphaltic road oils were exhibited by the Aztec Oil and Asphalt Refining Company of Canada, British American Oil Company, Elder-Ebano Asphalt Company, Limited, and Imperial Oil Company. Tarvia and Barrett Specification Roofing were exhibited by the Paterson Mfg. Company. The Canada Creosoting Company, Limited, exhibited wood paving blocks and methods of creosoting railroad ties and bridge timbers. The Canada Cement Company, Limited, exhibited methods of concrete construction for roads and streets, in addition to a number of novel ways of using cement. The Dunn Wire Cut Lug Brick Company and its licensees had a joint exhibit.

Among the machinery manufacturers, the largest exhibits were those of Mussens, Limited, and of the General Car and Machinery Works, both of these firms exhibiting some machinery of almost every type necessary for road construction.

The Canadian Fairbanks-Morse Company, Limited, had a large exhibit of mixers, pumps, Koppel dump cars and other contractors' equipment.

Road rollers were exhibited by Mussens, Limited, General Car and Machinery Works, Albion Motor Car Company of Canada, and the J. I. Case Threshing Machine Company. Sawyer-Massey Company had a booth, but were unable to get one of their rollers to Montreal in time for the exhibition.

Foss and Hill Machinery Company exhibited London concrete mixers, sidewalk forms and other contractors' equipment. The Pedlar People, Limited, constructed within their booth a Toncan metal garage, within which they exhibited corrugated culverts, Clinton wire cloth, ferro-dovetail and their various other lines. Corrugated culverts were also exhibited by the Canada Ingot Iron Company.

Baker-Barron, Inc., exhibited scrapers, graders and other road machinery. Alex. Bremner, Limited, exhibited builders' materials and municipal supplies. J. H. McCarty & Company exhibited Waterous road machinery. William McNally & Company, Limited, exhibited a Troy dump wagon and contractors' supplies. Jones & Glassco had in their booth a Foden steam truck.

The Decauville Flexible Armor Company of Canada exhibited a patented method of reinforced concrete brick construction for protecting embankments. Thomas Davidson Mfg. Company, Limited, showed samples of street signs, house numbers and other enameled steel products.

The technical and trade press was well represented, as there were exhibits by Good Roads, Canadian Municipal Journal, Good Roads of Canada, Contract Record, and *The Canadian Engineer*.

INTERNATIONAL ENGINEERING CONGRESS, 1915.

Among the general subjects to be treated before the International Engineering Congress, 1915, probably the one having the broadest interest is that of Materials of Engineering Construction, which enters into all phases of engineering activity. The list of topics which will be treated in this section is as follows:—

(1) Timber.
(2) Preservative Treatment of Timber.
(3) Substitutes for Timber in Engineering Construction.
(4) Brick in Engineering Structures.
(5) Clay Products in Engineering Structures.
(6) Probable and Presumptive Life of Concrete Structures made from Modern Cements.
(7) Aggregates for Concrete.
(8) Slag Cement.
(9) Waterproof Concrete.
(10) Cements containing Additions of Finely Ground Foreign Material.
(11) Economics of the World's Supply of Iron.
(12) The Life of Iron and Steel Structures.
(13) The Employment of Special Steel in Engineering Construction.
(14) The Place of Copper in the Present Engineering Field, and the Economics of the World's Supply Thereof.
(15) Alloys and Their Use in Engineering Construction.
(16) Aluminum in Engineering Construction.
(17) The Influence of the Testing of Materials upon Advances in the Designing of Engineering Structures and Machines.
(18) Cement Testing.
(19) Testing of M[illegible]
(20) Testing Full-Sized Members.
(21) Proof Testing of Structures.

The papers to be presented from the United States have already been arranged for from the recognized leading authorities on the various topics. Arrangements for the papers from authors in other countries are being rapidly concluded, and the aggregation of papers which will be presented will constitute [illegible] review of the field [illegible] of the highest value.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

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BOOK REVIEWS.

Heat.—By E. M. Shealy, Assistant Professor of Steam Engineering, University of Wisconsin; published by McGraw-Hill Book Co., New York City; 262 pp.; 110 illustrations; 6 x 9 in.; cloth. Price, $2. Reviewed by R. W. Angus, Professor of Mechanical Engineering, University of Toronto.

This book is one of the series prepared by the Extension Division of the University of Wisconsin and deals with the application of heat to various types of machinery, such as steam and gas engines, air compressors, etc. It is evidently written more from the view of the practical than of the technically trained man, as the use of formulas has been very largely avoided and where they do appear, they are not of a complicated nature, so that they are easily understood.

The first six chapters deal with the general principles required in studying the action of heat—e.g., temperature, work and power, transferring and measuring heat, as well as its generation and effect on gases. In many cases the discussion is illustrated by a simple physical experiment showing the meaning. Some attention has been given to insulation and heat transmission, through various substances, coefficients being supplied for practical application.

After the preliminary chapters the book follows along the same general lines as other books on applied thermodynamics except that the treatment is rather more elementary than is usual. Chapters VII. to IX. discuss the working fluids; gases and vapors, and include a table of the properties of vapors. The chapters on the steam engine are too brief and attempt to deal with too much—e.g., the Carnot's Cycle is dealt with in one paragraph and would not be of much help to a beginner whose ideas are not well formed.

The parts dealing with air compressors, gas engines and refrigerating machines are also brief but contain some very helpful material.

The work concludes with a chapter on house heating and would prove of help to men desiring an elementary general knowledge of the important applications of heat in the production of power, etc.

Engineers' Costs and Economical Workshop Production. By Dempster Smith and P. C. N. Pickworth. Published by Emmott & Co., Limited, Manchester, Eng. 248. pp.; illustrated; 6 x 9 ins. Price, $1.25.

Shop superintendents and others responsible for carefully watching and keeping down costs in engineering workshops will appreciate the truth of a statement in the first chapter of this book which says "The acuteness of present day trading, however, has removed, in the majority of cases, the happy days of ample margins and has produced a state of affairs in which only by accuracy in the estimation of costs can a profit be relied on."

The book has avowedly been written "from the engineer's standpoint rather than from the accountant's."

After treating in the earlier chapters of the various qualities and grades of pig iron, wrought iron, steel and copper in commercial use, the authors pass on to specifications of materials as formulated by the British Engineering Standards Committee, thence to wage systems, shop qrganization, the time necessary for performing various operations, inspection work and classes of it, establishment charges, reserve maintenance and depreciation, freight charges, shipment of goods, cost keeping and estimating.

The foregoing shows that all the essential ground relating to cost of production has been covered and perusal of the book leads one to believe that the writers' know the subject with which they are dealing. It is evident that a great deal of time and care has been expended on this work, the subject matter is well put together and the diagrams are very clearly drawn. Avoidance of very abstruse mathematics is perhaps another point which will form a recommendation to some.

Practical Sanitation.—By George Reid, M.D., University of Cambridge; 17th edition. Published by Charles Griffin & Co., Limited, Exeter Street, Strand, London; 354 pp.; illustrated; 5¼ x 7½ ins.; cloth. Price, $1.50 net.

It will be noticed that this book is in its 17th edition and has evidently, therefore, filled a want in Great Britain.

Like most of Messrs. Griffin's publications, the book is a good one, and will be found to contain much information useful to "Insanitary Spectres" (as the maid of all work termed them), and others interested, for whom it has been written.

The first half deals with water supplies, ventilation, drains and plumbing work generally, and examples of both good and bad work are given; owing to differing methods of working, and to the fact that some of the appliances used here are not quite the same as those employed in the old country, portions of this section will hardly apply here, but this does not detract from the value of the book as a whole. Since the author is a medical man he has been able to incorporate into the later portions of the book a good deal of information regarding infection and disinfection, food, etc., which is well put together and apparently up-to-date.

Hydraulics. By Ernest H. Sprague, A.M.I.C.E., Assistant at University College, London; formerly Professor of Engineering at the Imperial Chinese Railway College, Shan Hai Kuan; 184 pages; 80 figures. Cloth, 4¾ x 7½-in. Published by Scott, Greenwood and Son, London, Eng. Price $1.

The author of this little book states that it has been compiled from his lecture notes and that it is intended to be

a text book for students and engineers. The title itself has been somewhat misapplied as the scope which the book includes is rather limited and does not cover the subject of hydraulics in any way exhaustively. It will be found, nevertheless, to be a concise, well-balanced text supplemented by a collection of very useful data for hydraulic engineers.

The chapters have the following arrangement: Introduction and principles of fluid pressure; liquids in motion; discharge through orifices, weirs, etc.; flow in pipes and channels; pressure of water and application to motors; pumps. The text is supplemented by 143 examples which can be strongly recommended to the student of hydraulics. The illustrations which the book contains are not well drawn, and are lacking in uniformity throughout. Otherwise they are of great value to the text.

The author has made free use of the Calculus, but his deductions have been carefully made and no engineer is apt to consider that he has over-rated its value to the subject at hand.

Practical Locomotive Operating.—By Clarence Roberts, Assistant Road Foreman of Engines P.R.R., and Russell M. Smith, Air-Brake Instructor P.R.R. Published by J. B. Lippincott Company, Philadelphia, Pa. 292 pages; fully indexed; 92 illustrations; 5 inserts. Cloth. Price, $2. Reviewed by Geo. S. Hodgins, Mechanical Engineer, Transcontinental Railway, Ottawa.

This book is a "practical" book written by practical men for practical men. The subjects taken up are those that locomotive enginemen ought to know, and those who take a lively interest in railroad work, ought also to know. In Part I., the classes of locomotives are given, and the processes involved in locomotive operating, the power of locomotives, train resistance and locomotive efficiency are explained.

The processes involved are combustion, the generation of steam, its utilization and the impulsion, by adhesion, of the driving wheels. Some remarks are made about mechanical stokers. The point is clearly brought out, that such a stoker is not intended to surpass hand-firing in the matter of economy, it takes its place, and it is a most important place, when it does work far beyond the physical ability of the fireman to do.

The whole rationale of steam generation is gone into and a table of the properties of saturated steam is given. The authors admit that it is not definitely known how fast heat transfer through the firebox plates takes place, but good practice has at least empirically (that is by trial and experience) found that if the heating surface goes below 60 or 65 times the grate area, heat will be lost, as there will be more than the plates can transfer to the water. If the ratio between the two is much greater, the additional efficiency gained will be too small to compensate for the extra weight and cost. Next comes tractive effort and horsepower. The correct formulas are given and the whole matter is very clearly set forth. The important part played by adhesion is explained. This matter of adhesion is not, as a rule, made to occupy the position that it should have, and that its close connection to tractive effort, entitles it to.

The friction of the locomotive itself receives attention, and train resistance formulas are given and examples worked out. There is one ratio constantly given in technical papers which needs explanation. It is that got by dividing the tractive effort by the heating surface. To many this seems like a meaningless performance, but its value becomes clear, when, as the authors point out, the available tractive effort decreases while the speed increases, because at high speeds the cut-off is early and the mean effective pressure in the cylinders is thereby reduced. Take a given locomotive for example. Its wheels and cylinders remain constant, and the mean effective pressure is the variable. As the mean effective pressure changes, the tractive effort changes also. Several curves are plotted on a diagram and these show how this takes place. When the horsepower is calculated, mean effective pressure and speed are the two variables, and so at the highest speeds the indicated horsepower is a maximum, though the tractive effort is quite small as compared with slow speed. Tractive effort is drawbar pull, less internal friction, but it does not of necessity imply motion, while horsepower is the rate of doing work, that is the drawbar pull actually producing motion. Work is spoken of here in the mathematical sense of pressure acting through space or against resistance.

It is not our purpose to give a close or complete analysis of the whole book, or go into every detail. We have instanced these points to emphasize the plain practical nature of the work. Under the head of Classification of Locomotives Part II., the ordinary types come in for definite treatment, and the compound is dealt with in detail. The subject is well illustrated and the reasons for the various operations involved are told in plain language. There is a table of dimensions and characteristics in which a large number of locomotives, running on many railways, are given.

Part III. opens with a general and easily-understood explanation of physics, mechanics, dynamics, heat, temperature, etc., etc. Under the head of chemistry coal is defined technically, and its composition, heat values, etc., are made clear. The meaning and use of the British Thermal Unit is important, as many fuels are bought on the basis of the heat units they will give. The volatile and solid constituents of coal are distinguished. It is easy to see that carbon mon-oxide (CO) is the result of incomplete combustion, and this results in the loss of heat which would otherwise be given off, if carbon di-oxide (CO_2) was formed. An interesting proof of this may sometimes be seen by looking at the top of chimneys of rolling mills, etc. When carbon mon-oxide is formed in the furnace it is carried up the flue as very hot smoke. At the top of the chimney when meeting the air, it bursts into flame, and CO burns to CO_2, thus completing the combustion without raising the temperature of the furnace. The loss thus becomes actually visible.

Part IV. deals with steam, states Boyle's or Mariott's law, and gives a comprehensive table of physical properties of saturated and superheated steam. The generation of steam and the work done in its formation are interesting subjects and the expansion of steam and cylinder condensation naturally follow in the book. The advantages of superheated steam are set forth and it easily becomes clear to the reader what happens and where economy comes in, with cylinders which may be supplied with superheated steam, approximately to a perfect gas with margin enough to meet inevitable cooling; and the same cylinders filled with saturated steam close to the dew point and which is little better than high pressure fog. Part V. is devoted to boilers, and in this section classes and types appear, construction features, superheaters, draft appliances, safety devices, parts and appurtenances; with boiler power data, and it concludes with remarks on injectors.

Part VI. takes up lubrication and lubricants. Part VII. follow with cylinders and valves and valve gear. Part VIII. is eminently practical and deals with running and firing. Here the rationale of the whole process of firing and running an engine with care and economy is brought out. The values of the volatile hydro-carbons and the fixed carbon are given, as they theoretically are, together with the results

of experience and test. These facts are placed before the reader in concise form, and the why and wherefore is followed out to the end.

Part IX. deals with disorders, deterioration, pounds, blows, and breakdowns. Part X. takes up appliances and parts such as the brick arch, injectors, water gauges, lubricators, pop safety valves, flexible staybolts, and all the many etceteras that should be understood and studied by all those running, repairing, caring for, or designing engines. Part XI. is concerned with operating conditions, qualifications and responsibilities of the operating staff. The selection of men, co-operation between enginemen, health of employees, first aid, etc., and it closes with a series of questions on the subjects with which the book deals in detail. Part XII. gives the United States Federal laws respecting boilers and safety appliances.

The work is "a new book" in more senses than one, and may be said to be the latest word on running and firing. Locomotive engineers and firemen spend about half their time on an engine and it is therefore important for them to become familiar with all the parts and appliances of the machine, and to know the latest approved practices in running and firing, particularly about those types of engines equipped with superheaters, brick arches and improved valve gears. These appliances have caused a great increase in locomotive efficiency, and for their proper operation, a demand has been created for progressive locomotive engineers and firemen, possessing a high standard of intelligence. This book contains information that engineers and firemen ought to have, in order to pass examinations and fit themselves to do good work. The study of this book will encourage them to think and to develop their faculties by solving, or endeavoring to solve, the various problems which daily arise in locomotive operating. The scope of the work is designed to teach the high value of efficiency; for the knowledge of the science of locomotive running gives to the man possessing it, a legitimate feeling of security and self reliance and he is therefore worth more to himself and to the company he serves.

Alloys and Their Industrial Applications. By Edward F. Law. Second Edition, published by Charles Griffin & Co., London; pp. 332; 6 x 9 ins.; cloth. Price $3.50 net. Reviewed by A. S. L. Barnes, Hydro-Electric Power Commission of Ontario.

The main purpose of this book is indicated in the prefact to the first edition, to be the summarizing of "the existing state of our knowledge of mixed metals, paying special attention to the general principles and essential facts. . . . An attempt has also been made to present the subject in such a manner that it will be intelligible, not only to the student but also to the manufacturer and the engineer, for whom the volume is primarily written."

The author was at one time assistant to that master of metallurgy, the late Sir William C. Roberts-Austen, who has contributed so largely to our knowledge of metals, and particularly of alloys.

If association with so great a mind be of any benefit we should expect to find the subject in the present work dealt with in a thorough fashion; in this the writer has not failed, but has presented a vast amount of detailed and interesting information in well arranged form.

A great many problems connected with alloys still remain unsolved, and there is a wide field for research still open in connection with them.

Engineers with some knowledge of electricity will be interested in the fact that while, as is well known, the pure metals all show a tendency to become perfect conductors of electricity at the absolute zero of temperature, alloys by no means do so; this difference in behaviour is said to be due to the fact that in the latter electric currents circulate within the materials owing to the presence of dissimilar metals, an opposing electro-motive force being set up, thus making their ability to oppose the passage of an external electric current through them greater than is the case with pure metals. The union of certain metals bringing about a great evolution of heat is a fact now familiar to all through the well-known "thermit" process so largely employed for railwelding, etc., but a combination of metals is referred to in this volume in the union of which there is an absorption of heat to such an extent that the temperature of the mixture falls from +17°C. to —10°C., or a drop of nearly 50°F. The book contains tables setting forth the properties of many different alloys, together with, in some cases, remarks as to their suitability for certain purposes. Chapters on brasses, bronzes, aluminium alloys, silver and gold alloys, iron and miscellaneous alloys and analysis are given as well as much information as to methods of investigation, influence of temperature, etc. As to the last named item, however, it is remarkable that a vain search was made through the whole book for any information relating to the temperature co-efficient of expansion of alloys; apparently this point has been completely overlooked, as it can hardly be argued that it is one of no importance in practical work—in some cases it is necessary to have this information.

One unusual, though by no means objectionable feature, may be noted, and that is the insertion of a brief bibliography at the end of some chapters relating to their subject-matter, instead of putting them all together at the end of the book.

PUBLICATIONS RECEIVED.

Nova Scotia Steel and Coal Co., Limited.—Report of the thirteenth annual general meeting of shareholders, held on March 25, 1914.

Bathurst District, New Brunswick.—Memoir No. 18-E, by G. A. Young; issued by Geological Survey branch, Department of Mines, Ottawa. A report on the Bathurst District, New Brunswick, and the Nipisiguit iron ore deposit together with maps.

Geology, and Mineral Deposits of the Tulameen District, B.C.—Memoir No. 26, by Charles Brock, and issued by the Geological Survey, Department of Mines, Ottawa. An illustrated report on the general characteristics, geology, and mineral deposits of the Tulameen District, B.C.

Some Myths and Sales of the Ojibwa of Southeastern Ontario.—Collected by Paul Radin and issued by the Geological Survey, Department of Mines, Ottawa. This interesting memoir contains myths collected by Mr. Radin in connection with the study of the ethnology and linguistics of the Ojibwa of Southeastern Ontario.

Proceedings of the First Annual Industrial Safety Conference. This conference was held at Reno, Nevada on January 26 and 27, 1914, a report of the proceedings being published by the University of Nevada. This report includes papers, talks, and discussions by prominent members of the conference, in connection with the "Safety First" movement in Nevada.

The Quantity System of Estimating.—By G. Alexander Wright, President of the Technical Society of the Pacific Coast. This leaflet is a brief treatise on the quantity system of estimating, a subject in connection with which Mr. Bell has devoted considerable thought and activity. By this system, Mr. Bell maintains, present estimating and contracting methods will be greatly bettered.

Clay and Shale Deposits of New Brunswick.—Memoir No. 44, by J. Keele, published by Geological Survey, Department of Mines, Ottawa. This report is on the result of investigations to determine whether the clay and shale deposits in New Brunswick were of sufficient extent to be of economic value, or of use to manufacturers of burned clay wares, for structural or other purposes.

Electrical Furnaces for Making Iron and Steel.—Bulletin No. 67 of investigations carried out by the Bureau of Mines with a view to increasing safety efficiency and economic development in metallurgical industries. The application of electricity to various processes, and especially to those in the manufacture of iron and steel, is given special attention. This bulletin gives some of the results of work already done, a brief historical review of the development of electric furnaces for making iron and steel, and discusses the problems that remain to be solved in the use of electric furnaces for the smelting or iron ores and the production of pig iron at a profit on a commercial scale.

CATALOGUES RECEIVED.

Rope Drives.—An 8-page pamphlet issued by the Mesta Machine Co., Pittsburg, Pa., and describing installations of rope drives for almost all conditions of service.

Sewage Disposal Plants.—Bulletin, series "G," No. 1, describing apparatus, equipment, and complete plants for sewage disposal. Issued by the Sanitation Corporation, New York.

Watthour Meters.—Circular No. 1137 containing 24 pages descriptive of watthour meters for alternating and direct currents. Issued by Canadian Westinghouse Co., Limited, Hamilton, Ont.

Turbine Pumps.—Bulletin No. 2001, issued by Canadian Allis-Chalmers, Limited, descriptive of the construction, working principles and applications of the Mather and Platt patent high-lift turbine pumps.

Axtec Asphalt.—The Interocean Oil Co., of New York, have issued a well gotten-up catalogue describing Aztec asphalt, its composition, use and advantages. This catalogue is well illustrated and contains 28 pages.

Cochrane Meters.—Engineering leaflet describing the practical uses and advantages of Cochrane meter heaters, feed water meters, and independent meters. Issued by the Harrison Safety Boiler Works, Philadelphia, Pa.

Iroquois Road and Street Paving Machinery and Tools.—A 16-page catalogue illustrating and describing road rollers, bituminous mixing plants and other road-making appliances Issued by Barber Asphalt Paving Co., Buffalo, N.Y.

Low Voltage Lighting Outfits.—A comprehensive bulletin describing the simplicity, adaptability, and convenience of low voltage lighting outfits for minor lighting purposes. Issued by the Northern Electric Co., Limited, Montreal.

The Lighting of Wood-Working Plants by Modern Methods.—A 12-page bulletin, describing and illustrating the possibilities of Mazda lamps for wood-working establishments. Issued by the Canadian General Electric Co., Limited, Toronto.

Motor-Driven Pumps.—A 24-page illustrated catalogue describing the advantages of the motor drive for pumps, the application of motors to pumps, and various pumping data, issued by the Westinghouse Electrical and Manufacturing Co., East Pittsburg, Pa.

Morris Trolleys.—Illustrated bulletin issued by the Herbert Morris Crane and Hoist Co., Limited, Toronto, dealing with the various types of travelling trolleys made by that company. Illustrations, diagrams and tables of dimensions are arranged in handy form.

Giant Cranes.—An elaborate 116-page catalogue issued by the Deutsche Maschinenfabrik, A.G., Duisburg, Germany, describing their stationary, travelling, slewing and floating cranes. This catalogue is profusely illustrated with fine halftones of cranes in operation.

The Lighting of Machine Shops and Metal-Working Plants.—Illustrated bulletin No. 43,402 describing the importance of perfect lighting, the method of lighting and the superiority of Edison Mazda lamps for such lighting. Issued by Canadian General Electric Co., Limited, Toronto.

Forging Ahead in Business.—An interesting 88-page catalogue published by the Alexander Hamilton Institute, of New York. This catalogue is descriptive of their modern business course and service, and gives a brief biological sketch of each of the Advisory Council and staff and of the special lecturers.

Tarvia, The Modern Binder, Road Preserver, and Dust Preventative.—A finely-illustrated 48-page catalogue issued by the Barrett Manufacturing Co., New York, describing the preparation and application of their tar dust layers and tar binders. The illustrations are of fine roadways, streets and drives treated with or constructed from Tarvia.

Avery Automatic Scales.—20 pp. of illustrated and descriptive information of this type of automatic scales for coal and water in power plant installations and of totalizers, crane scales of various types for industrial service, issued by the Avery Scale Company, for whom Canadian Allis-Chalmers, Limited, Toronto, are Canadian agents.

Railway Sign Apparatus:—A 24 pp. catalogue descriptive of model 2-A signal of the General Railway Signal Co., Rochester, N.Y. Also a 64 pp. pamphlet descriptive of the same in a very convenient size containing numerous circuit diagrams, instructions for installation and maintenance, etc. The company have also issued a 12 pp. bulletin descriptive of their plate rail clips and detector bars; also an 8 pp. description of their improved lightning arrester.

United States Steed Products Company.—General catalogue 1914, third edition, dealing completely with their many products, including rails, cross ties, switches, bonds, billets, blooms, etc.; also structural steel for buildings, bridges, derricks, etc. The catalogue comprises 635 pages, and covers almost every conceivable product, such as horse shoes, wire springs, tacks, nails, spikes, cables, ropes, fence wire, reinforcing mesh, music wire, etc.; conversion tables of weights, measures, specifications for structural work, steel railway bridges, steel axes, etc., etc.

Demag Cold-Rolling Machinery.—A handsome, finely-illustrated catalogue issued by Deutsche Maschinenfabrik A.G., Duisburg, Germany, describing their cold-rolling machines for the manufacture of long bands of steel, brass, iron, copper, tin, zinc, etc. Other types of rolling mills, circular and roll shears, straightening machines and other auxiliary equipment for rolling mills are described and illustrated. This catalogue, containing 48 pages, is representative of a high-grade manufacturing plant.

AREA OF THE PROVINCE OF ONTARIO.

On page 739 of our issue of May 14th, the division, by the Public Roads and Highways Commission of the Province of Ontario, as set forth in their recent report, does not include the addition of the district of Patricia in 1912. Two hundred and sixty thousand square miles represented the approximate area prior to this addition. The total area of the Province is now four hundred and seven thousand two hundred and sixty-two square miles, according to published statistics of the Department of the Interior, Ottawa.

Coast to Coast

Clinton, Ont.—Hydro-electric power was officially turned on at Clinton on May 20.

Hamilton, Ont.—$400,000 is being expended on extensions to the street railway system at Hamilton this year.

Neepawa, Man.—Recently, the waterworks dam has broken at Neepawa, Man., at a loss to the town of $3,000.

Toronto, Ont.—A report of statistics issued recently by the city waterworks department shows a deficit for 1913 of $141,371.

Baxter, Ont.—The centre span of the new viaduct over the Nottawasaga River at Baxter, sank recently, and will require to be repaired.

Moose Jaw, Sask.—The cost of the street paving, for which the city of Moose Jaw is now calling tenders, is placed at between $50,000 and $6[illegible].

St. Boniface, Man.—The Western Tire and Rubber Co., will locate its new factory, which will cost $175,000, at St. Boniface, rather than at Regina, as previously intended.

Regina, Sask.—Without taking into consideration the cost of labor, Regina will spend $28,075 in extensions to the electric light distribution system during the present year.

Calgary, Alta.—It is reported that lack of funds will cause the Grand Trunk Pacific Railway Company to delay starting the work of constructing its $300,000 station at Calgary.

Guelph, Ont.—Grading has been completed from Toronto to Guelph on the Toronto Suburban Railway line, and for the greater part of the distance ties have been distributed and rails unloaded.

Preston, Ont.—A proposition from the Building Product Co., manufacturers of sand bricks and other building material, offering to establish at Preston a $50,000 plant, is being considered by the municipal council.

Montreal, Que.—It is reported that 170 tenders were received at Montreal for 1914 street paving, and deposit cheques to the amount of $2,250,000 were received. The city will expend this year on pavement about $1,500,000.

Leaside, Ont.—The work on waterworks and sewage plants and systems, for which contracts have just been let, will entail an expenditure of around $100,000, which will be supplemented by the expenditure of $50,000 on roadways, pavements and other general improvements.

Quebec, Que.—The new 40-inch water pipe being laid in Quebec is almost completed. The whole of the lower portion of the city is already being supplied with water from this new main, and connection is being completed in the upper part of the city, while tests are being made.

Regina, Sask.—An effort is being made by the business men of Regina to have the Dominion Government extend its telegraph line from Qu'Appelle to Regina. It would be necessary to extend the existing line 70 miles to connect it with Regina, and the cost per mile would be approximately $1[illegible].

Winnipeg, Man.—The sum of $371,000 is being advanced to the city council by the sinking fund trustees for concrete lanes, street openings, granolithic sidewalks and No. 2 asphalt pavements for residential districts. This is in addition to $125,000 already loaned this year to the council, and [illegible] total $4[illegible].

Brantford, Ont.—The civic authorities and the Dominion Railway Commission have approved the general plans of the Lake Erie and Northern Railway Company for the raising of [illegible] and for the construction of the inner retaining wall of the railway, and it is expected that this work will commence at once.

St. John, N.B.—Mr. A. R. Gould, contractor for the railway being constructed down the St. John River valley from Woodstock, N.B., to the city of St. John, known as the St. John Valley Railway, when in Montreal recently, stated that the line between Gagetown and Centreville will be finished this year, and the track will be laid.

Montreal, Que.—Objections have been raised to the city conduit plant and construction work, and these must be considered by the Electric Service and Public Utilities commissions before final approval can be given for proceeding with the work. The chief objection to the St. Catharine Street conduit is that it was not provided for ventilation.

Winnipeg, Man.—After deducting the total operating expenses of $41,252.09 from the total revenue, the balance sheet of the city of Winnipeg hydro-electric system shows a surplus of $10,666.77 for the month of March. The deficit, which was incurred during the early months of the system's operation is gradually being reduced and this month stands at $86,156.60.

Sault Ste. Marie, Ont.—The amount which the city of Sault Ste. Marie will pay the Tagona Water and Light Co. for the water and light system on October 14 next, when their franchise expires, has been fixed by the arbitrators at $413,537.51. To this is to be added the statutory 10 per cent., which brings the total up to $454,891.26. The Tagona Water and Light Co.'s original figure amounted to $724,561.05.

Galt, Ont.—In his report on the waterworks system of Galt, Norman L. Wilson, the inspector for the Fire Underwriters' Association, pointed out an inadequate reservoir supply, and an inadequate source of water, artesian wells, showing evidence of diminishing the flow therefrom. He urged immediate steps to enlarge the visible supply reservoir to 3,000,000 gallons. The water commission has been considering means to increase the water supply for some time.

Yorkton, Sask.—The Yorkton board of trade sent a delegation recently to Winnipeg to endeavor to induce the C.N.R. to hasten the construction of its Yorkton branch, which is at present completed to within 18 miles east of the town and graded as far as 20 miles west. The delegation was also commissioned to ask both the C.P.R. to extend its yards and to make improvements generally, and the G.T.P. to continue its train service which was in operation a year ago. It is stated that the last request has practically been granted.

Vancouver, B.C.—It is expected that by June 1, a portion of the wharf of the new dock which is being established on the south side of False Creek near the Great Northern bridge at Vancouver, by Messrs. McNeill, Welsh and Wilson, Limited, will be completed. The wharf is 308 feet long and 176 feet wide, and will be approached by a roadway from the present end of Front and Ontario Streets. A large tract of foreshore between the railway bridge and the dock is to be reclaimed in connection with the dockage scheme, and will be used for trackage facilities.

Chatham, Ont.—The Chatham Gas and Electric Light Company has renewed its offer to sell its plant to the city for $410,000, plus the amount spent on capital account since the valuation of the plant made by the Hydro-Electric Commission. It is the intention of the city to use the plant of the gas company as a distributing station for Niagara power and to operate the gas end of the business as a public utility. The Hydro-Electric Commission recommended this deal to the city as the best business proposition when the city installed hydro-power. The council will give a decision within two weeks.

Winnipeg, Man.—What is stated to be a record piece of railway construction work has been accomplished by the

C.P.R. in the building of its Bassano-Swift Current line. This line is now complete from Bassano to Saskatchewan River, a distance of 125 miles. Track laying was started on March 1 last and was completed on May 15. In the last three days 12 miles of track were laid, 6 of these being done on the last day. The rails used are 85 pounds, and in the construction of the line, 2,900 ties to the mile were used. There are also 15 miles of passing and side tracks in the 125 miles completed.

Calgary, Alta.—No remaining doubt is now held concerning the commercial value of the oil which has been struck at the well of the Calgary Petroleum Produce Company near Black Diamond, and about 40 miles south-west of Calgary. The latest reports show that the fluid is almost pure gasoline, and that there were 500 feet of oil in the well, when it had reached a depth of 2,718 feet. Moreover, it is reported that on May 20, oil spouted from the Dingman well fully 90 feet into the air, and that after baling for more than four hours, there was no perceptible decrease in the height of the oil in the pipe, which remained at 2,000 feet. It is now estimated that within the next 60 days, drilling on about 100 wells will be commenced.

Victoria, B.C.—The decision has been announced from Ottawa that the new Government telescope, which is to be the largest in the world, and which is to cost $90,000, will be erected at Victoria, B.C. The instrument will be placed at the summit of Little Saanich Mountain, 7 miles from Victoria. Atmospheric conditions at Victoria have been found to be almost ideal for observation purposes. Tests at various places throughout Canada were made, but the decision was in favor of Vancouver Island. The new telescope has a reflecting lens of 72 inches and is 30 feet long. It weighs 8 tons, while the moving apparatus weighs 40 tons. The telescope costs $90,000 and the cost of the whole plant will be $200,000. The telescope and observatory were designed by Dr. Plaskett, of the Observatory Staff at Ottawa.

Regina, Sask.—In August a new 3,000 k.w. electric light unit will arrive at Regina to be installed at the new power house, and will give sufficient equipment in the two power houses to handle double the city's load, and to ward off inconvenience to consumers in case of a breakdown. The new machine will have twice the capacity of any of the units at present installed; though in appearance it will not be very much larger than the 1,500 k.w. units. The consumption of electric energy is increasing very rapidly, and at the present rate of increase the new machine will be needed for constant use soon after it is installed. Wilson and Wilson, who were awarded the contract for the completion of the new power house, are assembling machines on the ground, and it is expected that actual construction work will be under way this week.

Vancouver, B.C.—As proposed by H. J. Kaiser, a contractor on one of the city's paving works, a new pavement, which may take the place of macadam on Vancouver's streets, will be laid on a section of Fourteenth Avenue. It is a bituminous mixture 5 inches in thickness made up of sand and gravel, bound together with bitumen. There is no concrete base, but the mixture is laid on the surface of the ground and rolled smooth. It will cost $1.35 a square yard as compared with 90 cents to $1 for macadam. The pavement will be guaranteed for five years, and it is believed may last twice that time; and it is declared that the extra cost will be more than saved in the lower expense of maintenance. It is stated that this pavement has been used extensively in United States cities.

Victoria, B.C.—The Burrard Engineering Company, of Vancouver, to which has been let the contract for the fabrication and laying of the pipe in connection with the Sooke Lake waterworks system, has [illegible] the [illegible] Westholme Lumber Company at Thetis Cove, Esquimalt Harbor, and will use this for the fabrication of the pipe. The company expects to be in a position to deliver pipe in about two or three weeks; and, so that no delay may be encountered when the pipe is ready, within the next week or 10 days the city will commence work on the excavation of the 10-mile trench in which the steel pressure pipe will be laid from Humpback Reservoir to the city. With the commencement of the laying of the reinforced concrete pipe along the section from Sooke Lake to Cooper's Cove, and a start on the laying of the steel pipe line from the reservoir to the city, the operations on the waterworks system for Greater Victoria will enter its final stage. The city will soon complete its work and there will be nothing in the way of the pipe line contractors pushing ahead their part of the contract.

Vancouver, B.C.—Tracklaying has been commenced on the extension of the P.G.E. Railway from Dundarave to Horseshoe Bay, and it is expected to have the line completed to the Howe Sound end early in June. The section is to be ready for operation by July 1. The railway company, in order to expedite operation on the Dundarave-Horseshoe Bay portion of the route, is building bridges in advance of the tracklayers. This involves greater expense in transporting materials; for timbers and steel have to be floated on rafts to the different bridge sites. Additional orders have just been placed by the P.G.E. for gasoline locomotives and rails. Two heavy engines of the consolidated type have been purchased from the Canadian Locomotive Works of Kingston, Ont., and three large passenger coaches have been bought. The company already had previous to these orders two locomotives on order and four in service. Sufficient steel to lay more than 300 miles of track has been ordered from the Algoma Steel Co. of Sault Ste. Marie, for delivery during the present year and up to the end of 1915. These consignments will aggregate between 30,000 and 40,000 tons. Contractors are now preparing to start active construction operations on the sections south of Fort George and north of Clinton; and a number of subcontracts are expected to be let at an early date for other portions of the line.

Regina, Sask.—In addition to many large buildings to be erected at Regina, the city has this year entered upon a programme of local improvement work which will require an expenditure of $2,033,264.03. The works and the expenditures estimated are as follows: waterworks general, $360,000; water main extension, $127,752; domestic sewer extensions, $142,145.23; storm sewers, $170,000; sewage disposal works, $61,520; street railway extensions, $250,000; pavement, $452,946.80; sidewalks, $65,000; and electric light and power, $404,000. Some of the many large buildings which at present are either under construction or are proposed to be erected at Regina, are given as follows, together with their estimated costs: G.T.P. Railway hotel, $1,000,000; G.T.P. station, laundry, train sheds, power house and tunnel, $1,000,000; Methodist College, towers and residence, $125,000; Rose theatre, $50,000; two business blocks, $75,000; Dominion Government buildings, $225,000; Campbell, Wilson and Strathdee warehouse, $112,000; General Hospital addition, $75,000; police station, $180,000; power house, $450,000; Woolworth's stores, $50,000; Nurses' Home, between $80,000 and $90,000; Metal, Shingle and Stamping Co.'s building, $[illegible]; [illegible] Lake Milling Co.'s mill, $300,000; Regina incinerator (now completed), $65,000; Presbyterian College, $1,000,000; Merrill and Garbutt [illegible], $[illegible], and [illegible], $[illegible]. It is stated [illegible] that the Roman Catholic Church will [illegible] a college at Regina, and that construction will likely commence this year. Moreover, many large apartment blocks, and other buildings to cost less than $50,000, will be erected this year in this city.

PERSONAL.

C. E. FOWLER, C.E., of Seattle, who is the author of the article entitled "Important Principles of Bridge Design," in this issue, on May 15th, delivered an illustrated lecture before the Vancouver branch of the Canadian Society of Civil Engineers on the harbors of the world.

H. D. MAPLES has been appointed superintendent of building construction for the C.P.R. in succession to F. L. Ellingwood. For a number of years Mr. Maples was vice-president of J. V. Schafer, Jr., and Company, a contracting firm of New York. He entered the service of the C.P.R. two years ago as assistant to Mr. Ellingwood. Mr. Maples has had 22 years' experience as an engineering contractor.

Recent appointments to the staff of the Topographical Surveys branch, Department of the Interior, Ottawa, includes, Messrs. E. A. Hodgson, Toronto; R. H. Field, Fort William; D. H. Campbell, Rodney, Ont.; H. C. Johnson, Ottawa; C. C. Fitzgerald, Parry Sound; G. L. Wallace, Toronto, and J. H. Hawes, Toronto.

OBITUARY.

The death occurred last week of Mr. A. C. Morris, secretary-treasurer of the Ontario Wind Engine and Pump Co. Mr. Morris came to Canada 27 years ago at the age of 23. He became connected with the Brockville Motor Co., but afterwards came to Toronto, and has been in the employ of the Ontario Wind Engine and Pump Co. since.

We regret to record the death of Alex. K. Kirkpatrick, C.E., of Queen's University, Kingston. Professor Kirkpatrick was prominently known among Canadian Civil Engineers. His connection with the Canadian Pacific Railway on several of its important projects, and his latest work, viz., the design of the Government car ferry service between Prince Edward Island and Cape Tormentine, N.B., have been well worthy of professional approval, and are an indication of his ability. Prof. Kirkpatrick was at the head of the Department of Civil Engineering at Queen's University. He was a member of the Canadian Society of Civil Engineers. At the time of his sudden death he was at Cape Tormentine in connection with the construction of the car ferry.

DESIGN OF THE OSHAWA POWER PLANT.

In the issue of May 21st, we overlooked mentioning, in connection with the article entitled "Oshawa Sub-Station of the Electric Power Co.," that the plant was designed by the engineering firm of Smith, Kerry and Chace, Limited, Toronto.

OFFICERS OF ELECTRIC RAILWAY ASSOCIATION.

At a recent convention, in Ottawa, of the Canadian Electric Railway Association, the following officers were elected:—President, C. B. King, manager, London Street Railway; vice-president, J. D. Fraser, secretary-treasurer and director Ottawa Street Railway; secretary-treasurer, Acton Burrows, Canadian Railway and Marine World, Toronto; executive committee—E. P. Coleman, general manager Dominion Power and Transmission Co., Hamilton; A. Eastman, vice-president and general manager Windsor, Essex and Lake Shore Rapid Ry., Kingsville; A. M. Hopper, general manager St. John, N.B., Street Ry.; Wilson Phillips, superintendent Winnipeg Electric Ry.; C. L. Wilson, assistant manager Toronto, York Radial Ry.; Patrick Dubee, secretary-treasurer Montreal Tramways Co.

REORGANIZATION OF WINNIPEG ENGINEERING DEPARTMENT.

At the resignation of Col. H. N. Ruttan, after 29 years of service as city engineer of Winnipeg, a reorganization of the city engineering department was decided upon by the board of control and the city council. As stated in a recent issue of this journal, Col. Ruttan is being retained as consulting engineer, and W. P. Brereton, B.A.Sc., chief assistant engineer, has been appointed to fill the vacancy on the engineering staff.

Whereas in the past, Col. Ruttan has been head of the entire department, and responsible for all matters pertaining to its branches, the new policy divides the department into sections with recognized heads over each, directly responsible to the board of control, although the new city engineer will be vested with the same authority as in the past. Thus Mr. Brereton, in his new position, will have general supervision. Mr. Wm. Aldridge, who has been in the city service for 14 years, is to have charge of office work, designing and detail specifications. Mr. Byde Hallock, who has also been in the city's employ for many years, having been in charge of outside construction work, is to be field engineer, thus continuing for the most part, the work upon which he has been engaged, including pavements, sewers, water mains, sidewalks, etc, The operation of the waterworks department will be under Mr. Thos. H. Hooper. This sub-department will not include construction, but only operation of the whole system, including the wells outside the city limits. Mr. Paul Schioler will be in charge of bridge construction and maintenance. He has been bridge engineer to the city for the past five years.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eighth Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chaussé, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21749—April 27—Authorizing Cedars Rapids Mfg. and Power Co., of Montreal to take additional width of 24.8 ft. for right of way for its transmission line across East Half Lot 31, Con. 1, Tp. Lancaster, Co. Glengarry, Ont., property of D. Ross Ross, subject to and upon certain conditions.

21750—May 1—Appointing P. H. Drayton, Esq., K.C., as arbitrator to inquire into and determine what, if any, damages have been sustained by Heward Estate, in connection with construction of C.P.R. spur (Government Spur Line) in city of Toronto, Ont., and to fix compensation therefor.

21751—April 29—Directing that C.P.R., and O. and N.Y. Ry. Cos., on or before June 1st, 1914, schedule trains No. 30 and 305 (C.P.R.) and No. 20 (O. and N.Y.) at Finch, Ont., at 9.52 a.m., and to carry out certain directions in connection wih said trains; and rescinding Order No. 19265, dated May 13th, 1913.

21752—May 2—Approving and authorizing clearances as shown on C.P.R. plan showing clearances on Rogers Pass Tunnel, subject to condition that Ry. Co. keep its employees off top and sides of cars operated through said tunnel.

21753—May 2—Relieving G.T.R. from providing further protection at crossing of highway first west of Stoney Creek, Ont.

21754—May 4—Approving revised location G.T.P. Branch Lines Co., Moose Jaw Northwest Branch from North Boundary of Sec. 19-22-7, to East Boundary of Sec. 25-22-8, W. 3 M., mileage 73.34 to 77.98, Dist. Moose Jaw, Saskatchewan.

21755—May 4—Authorizing C.P.R. to construct bridge No. 18.1 on Moose Jaw Subdivision, Sask. Division, Saskatchewan.

21756—May 4—Authorizing C.P.R. to construct diversion of Old Trail to Medicine Hat, in Sec. 36-22-29, W. 3 M., Sask.; and construct, at grade, track of its Swift Current Northwesterly Branch Line across said diversion.

21757—May 4—Directing that, within 90 days from date of this Order, C.P.R., install improved type of automatic bell at crossing of first public highway east of Central Ontario Junction, and thereafter maintain bell at own expense; 20 per cent. of installation of bell be paid out of "The Ry. Grade Crossing Fund," remainder by Railway Company.

21758—May 6—Approving revised location portion of C.P.R., Swift Current Northwesterly Branch Line, from point in Sec. 14-36-11, W. 4 M., mileage 0, in northwesterly direction to point in Sec. 6-38-11, W. 4 M., mileage 10.82 of said Branch Line (mileage 0-105.60 Lacombe Subdivision).

21759—May 5—Authorizing C.P.R. to construct tracks of storage siding, at grade, across public road between city of Guelph and Tp. Guelph, Co. Wellington, Ont., at mileage 30.33, Ont. Div. Hamilton and Goderich Subdivision.

21760—May 6—Authorizing, subject to conditions contained in Order in Council, Dominion Atlantic Ry. to reconstruct bridge over Bear River, Co. Digby, N.S., and approving plan No. B-1-1261, marked plan "A," showing location of proposed temporary lift span in old bridge.

21761—May 5—Authorizing C.P.R. to construct spur for Builders Supply Co., Limited, Winnipeg, Man., in Sec. 36-11-4 E.P.M., on lands owned by Builders Supply Co., Limited.

21762—May 5—Authorizing C.P.R. to take certain lands in city of Ottawa, Ont., for purpose of enlarging Sussex St., terminals in said city of Ottawa.

21763—May 6—Authorizing C.P.R. to construct change in location of spur for Security Lumber Co., Limited, Moose Jaw, Sask., from point on existing spur in Subdivision Lot 35, thence across Subdivision Lots 35 to 22, both inclusive, Block 98, city of Moose Jaw, Sask.

21764—May 6—Approving location and details of C.N.Q. Ry. station at Lac aux Sables, Quebec.

21802—May 13—Approving Bell Telephone Co.'s agreement entered with Pontiac Rural Telephone Co., Limited, dated April 3rd, 1914, for interchange of telephone messages or service passing to or from their respective telephone systems, division or apportionment of tolls, and management, working, or operation of respective telephone systems, etc.

21803—May 14—Approving location C.P.R. station at Ringold, Lot 8, Con. 3, Tp. Raleigh, Co. Kent, Ont., mileage 70.99, Windsor Subdivision: Provided, whenever highway is blocked for more than 5 minutes at any one time by reason of location hereby approved, Board shall be at liberty to re-locate said station.

21804—May 14—Authorizing C.P.R. to construct spur for George White & Sons, Co., Limited, city of Moose Jaw, Saskatchewan.

21805—May 14—Authorizing C.P.R. to construct spur for Mond Nickle Co., Limited, Coniston, Ont., in Lots 5, 6, and 7, Con. 6, Tp. of McKim, Dist. Sudbury, Ont., mileage 2.5 on Stobie Branch.

21806—May 14—Authorizing C.P.R. to construct spur for Thomas Fletcher, of Calgary, Alta.

21807—May 14—Relieving C.N.R. from speed limitation of 18 miles an hour over its line from Oak Point to Gypsumville, a distance of 97 miles; and directing that fencing of its line from mileage 69 be erected and completed by Oct. 1st, 1914.

21808—May 15—Authorizing C.N.O.R. to construct bridge to carry its line over Raimbault Creek, parish St. Laurent, Co. Jacques Cartier, Que., mileage 48.07 from Hawkesbury; and rescinding Orders Nos. 19657 and 21650, dated respectively June 21st, 1913, and April 15th, 1914.

21809—May 11—Approving G. T. P. Ry. plans showing stress diagram of superstructure and details of substructure of bridge across Nechaco River, mileage 371.4 Prince Rupert Easterly, B.C.

21810—May 16—Amending Order No. 20002, dated August 11th, 1913. 1. by substituting plan dated April 24th, 1914, for plan approved under Order No. 20002, and 2. by adding to last line of operative part of Order following words,—"and the Applicant Co. is hereby authorized, at its own expense, to raise the tracks of the C.P.R. Co., six feet at the point of crossing."

21811—May 11—Directing that classification of maple cheese be made same as that fixed by Order No. 21745, dated May 2nd, 1914, for maple butter; addition to be included in Supplement No. 3 to Canadian Freight Classification No. 16.

21812—May 16—Authorizing C.N.R. to reconstruct bridge over Sturgeon River, station 403, mileage 8.1, River Lots 53 and 25, St. Albert Settlement, Alberta.

21813—May 14—Authorizing C.N.O.R. to construct bridge over Indian River, Tp. Richards, Co. Renfrew, Ont., mileage 107.85 from Ottawa; and rescinding Order No. 120888, dated November 21st, 1913.

21814—May 16—Authorizing C.P.R. to open for traffic its line from mileage 0 to 10, Snowflake West Branch, Manitoba.

21815—May 13—Directing that, within 60 days from date of this Order, C.P.R. install automatic bell at crossing of Laviolette Avenue Three Rivers, Que., 20 per cent. of installation to be paid out of "Ry. Grade-Crossing Fund," remainder by Railway Company.

21816—May 14—Authorizing C.P.R. to construct spurs from point on north-easterly limit of right of way of main line, mileage 2.26, Muskoka Subdivision, Ont. Div., in Lot 1, Con. 4, west of Yonge St., Tp. York, Ont., on land owned by Canadian Kodak Co., Ltd.

21817—May 14—Authorizing G.T.R. to construct siding into premises of Brantford Industrial Realty Co., Ltd., south of Alice Street, city of Brantford, Ont.

21818—May 16—Approving and authorizing clearances as shown on C.P.R. plan showing clearances of overhead pipe line crossing sidings of Standard Paint Co. of Canada, Ltd., in Lot Cadastral No. 954, parish Lachine, Co. Jacques-Cartier, Que., at mileage 0.49, on South Bank Branch, subject to condition that Co. keep employees off top and sides of cars operated over said siding.

21819—May 11—Authorizing Hamilton Radial Electric Ry. Co., to construct spur, Tp. Saltfleet and Tp. Barton, Co. Wentworth, Ont. to and through lands of Sir Henry Pellatt and Dominion Power and Transmission Co., Ltd., at or near point marked "B," subject to certain conditions.

21820—May 11—Authorizing C.P.R. to construct extension to trackage for Gordon, Ironside and Fares Co., Ltd., Winnipeg, Man., and approving all clearances as shown on plan dated Winnipeg, April, 1914, subject to condition that Company keep employees off sides of cars when operated over said spur.

21821—May 11—Directing that C.P.R. construct roadway 66 ft. wide, commencing from north and south road allowance and running north-westerly to point south of dam, and thence north-westerly joining east and west road allowance in centre of Sec. 17 and 8; and reserving question of apportionment of cost.

21822—May 18—Approving revised location G.T.P. Ry. main line mile 220.60 to mile 230.30, Yellowhead Pass West, Dist. of Cariboo, B.C.

21823—May 18—Authorizing G.T.P. Ry. to operate crossing of Canadian Northern at Empire Ave., Fort William, without bringing trains to a stop.

21824—May 18—Authorizing G.T.R. to re-construct overhead bridge carrying farm crossing over tracks Lot 33, Con. 1, Tp. of South Dumfries.

21825—May 14—Amending Order No. 138, dated June 17th, 1904, which authorizes crossing by Sarnia Street Railway of G.T.R. (Point Edward Blackwell Branch) by adding clause that the Applicant Co., bear and pay the cost of maintaining and repairing the diamond.

21826—May 18—Authorizing C.P.R., to use and operate Bridge No. 144.6 on its Portal Subdivision, Saskatchewan Div.

21827—May 18—Extending until June 30th, 1914, the time for completion of siding for McCormick Mfg. Co., London, Ont., authorized by Order No. 20710, dated November 4th, 1913.

21828—May 11—Rescinding Order No. 21518, dated March 18th, 1914, which directed the C.P.R., to restore the old clearance at the bridge over North Branch of Clyde River, just north of Flower Station, Ont., by raising under side of top of culvert eleven inches.

21829—May 18—Extending until November 1st, 1914, the time for construction and completion of subway under C.P.R., in Regina, authorized by Order No. 12801, dated January 20th, 1911, on application of city of Regina.

21830—May 19—Authorizing Board of Highway Commissioners, Sask. to construct highway crossing over C.P.R., in S.W. ¼ Sec. 21, Tp. 19, R. 18, W. 3 M., Sask.

21831—May 16—Authorizing Cedar Rapids Manufacturing and Power Co. to take certain lands in Lots 3, 4 5, parish of St. Ignace du Coteau du Lac, properties of Mrs. O. S. Bissonnette.

21832—May 18—Authorizing town of Mont Laurier, Que., to construct highway crossing over C.P.R. at mile 134.45, Laurentian Subdivision, Tp. of Campbell, Labelle Co., Que.

21833—May 19—Authorizing C.N.R. to cross public road between Secs 14 and 15, Tp. 51, Rge. 12, W. 4 M.

21834—May 18—Authorizing C.N.Q. Ry. to construct spur to Dansereau's Mill, and to cross Bay St., Grenville, Que.

21835—May 18—Authorizing G.T.R. to construct spur from a point on the 16th Dist. of its railway on Ferguson Ave., Hamilton, to the Co.'s property west of Ferguson Ave.

21836—Directing the G.T.R. to change the grade of approaches to crossing [illegible] Durham and South Durham [illegible] Bergvine Crossing.

21837—May 18—Authorizing G.T.P.B.L. Co. to construct a bridge across South Saskatchewan River at mile 86.5 Young Prince Albert Branch, Saskatchewan.

21838—May 18—Directing that the C.P.R. within 60 days date of Order install electric bell at crossing in Mun. of Maple Ridge, Port Hammond, B.C.

21839—May 16—Approving change in location of C.P.R. station at Kreuzburg, Man.

21840—May 18—Approving plan showing subway proposed to be constructed at Anthony St., Strathcona, Edmonton, by the C.P.R.

21841—May 18—Approving C.P.R. plan showing clearances at its coaling plant at Aldersyde, Alta.

21842—May 19—Authorizing C.N.O.R. to construct crossing of Con. Road between Lot 10, Con. 5, and Lot 10, Con. 6, Tp. Nepean, Co. Carleton, Ont.; rescinding Order No. 17859, November 6th, 1912, in so far as it approved road diversion at said point; and rescinding Order No. 20110, dated August 18th, 1913.

21843—May 20—Authorizing Rural Mun. Colonsay No. 342, Sask., at its own expense, to construct highway crossing over G.T.P. Ry. Co.'s Prince Albert Branch in N.W. ¼ Sec. 28-34-27, W. 2 M., Sask.

21844—May 20—Authorizing C.P.R. to construct spurs for White Falls Lumber Co., Limited, Sudbury, Ont., from point on Northeasterly limit right of way of main line, Lake Superior Div., Algoma Subdivision, at Blind River, Lot 5, R. 1, Tp. Cobden, Ont.

21845—May 20—Authorizing G.T.R. to construct siding into premises of Messrs. Aitken and Sons, on Lots 60, 59, 58, 57, 56, 55 and 54 west of Dayfoot St., village of Beeton, Ont.

21846—May 19—Authorizing C.P.R. to construct temporary sidings for Dominion Bridge Co., Limited, Montreal, from point on main line right of way, across Cushing Road and Provincial Government lands in parish of Lancaster, Co. St. John, Province of N.B., mileage 1.92, St. John Subdivision, authority granted herein be effective for one year from date of this Order.

21847—May 19—Directing that C.L.O. and W. (C.P.R.) lay and maintain a 12-inch pipe under its embankment, in West ½ Lot 30, Con. 2, Tp. Pickering, Ont.; Frederick Roach of Cherrywood, Ont. (Applicant), to have right to lay water pipe through said 12-inch pipe for purpose of conveying water from spring to pasture.

21848—May 18—Refusing application of Bell Telephone Co., for leave to construct lines of telephone upon, along and across Concord St., Grey Ave. and Harvard Ave., city of Montreal; and granting leave to said Company to erect and maintain an overhead line on east side of Mountain St. said city, pending construction of permanent pavement on said street, when wires shall be placed underground.

21849—May 20—Amending Order No. 21734, dated May 2nd, 1914, by adding after word "Streets" in clause (2) of paragraph 1 of operative part of Order, the following: "the said wires forming part of the circuits which are dealt with under clause (1) of this Order."

21850—May 18—Directing that C.N.R. construct and maintain a dam on creek diversion near north boundary Sec. 16-31-15, W.4 M., Alta., the crest of dam to be 6 inches higher than top of pipe under railway embankment; work to be completed within one month from date of this Order; and rescinding Order No. 21139, dated December 31st, 1913.

21851—May 22—Authorizing C.P.R. to open for traffic its second main line track from Iberville Station, mileage 19.2, to mileage 20.02, St. Johns, Quebec.

21852—May 16—Approving location G.T.R. station at Penetanguishene, Ontario.

21853—May 22—Amending Order No. 10457, dated April 28th, 1910, by adding "that all moneys expended in acquisition of any property required for work, including lands required for diversion of Upper Lachine Road, and all moneys paid in satisfaction of damages and taxed costs resulting from work, or any part thereof, shall be considered as forming part of cost of work directed by this Order and shall be borne in the proportions above set out."

A report has been made to the effect that Vickers Maxim Company has secured control of the plant of the Collingwood Ship Building Company, and also the Kingston Ship Building Company, and that these works will be operated in conjunction with the navigation companies.

Volume 26. Toronto, June 4th, 1914 Contents of this issue on page 3

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

CASCADE RIVER POWER DEVELOPMENT

DESCRIPTION OF THE PROPOSED HYDRO-ELECTRIC PLANT AT BANFF, ALTA., FOR THE DOMINION PARKS BRANCH, DEPARTMENT OF THE INTERIOR.

IN the following article, taken from a report of C. H. Mitchell, C.E., consulting engineer to the Water Power Branch, Department of the Interior, the feasibility and commercial economic development is considered of a hydro-electric power project capable of supplying power to be used by the Dominion Parks Branch

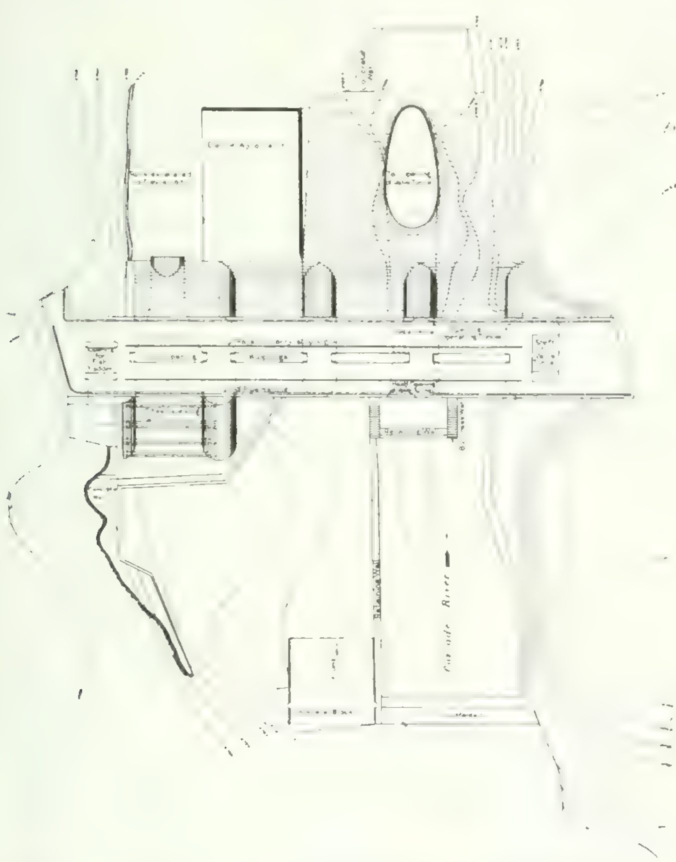


Fig. 1.—General Plan of Minnewanka Storage Dam of the Calgary Power Company.

to furnish the town of Banff, Alta., with light, transportation, etc., and to develop various electrical undertakings in the Rocky Mountains Park in the vicinity of Banff.

The Cascade River, where flowing through the canyon in which it is proposed to develop the power, is immediately below the confluence of Devil's Creek, which empties from Lake Minnewanka. The total area drained by these rivers is about 213 sq. mi., and lies wholly within the Rocky Mountains; much of the water originates in mountain lakes and some in glaciers. Lake Minnewanka has an area of about 14 sq. mi., and was, during 1912, converted into a storage reservoir for power purposes to improve the power facilities of the Bow River in its power-producing reaches in the foot-hills of the mountains.

The power site is about 7 miles from the town of Banff. The nearest railway point is at Bankhead coal mines, three miles from the site. The small town site, one mile above, on the shore of Lake Minnewanka, is likely to become almost entirely a summer place; the village of Bankhead has a mining population of permanent character serving the mines. The power site and all the other portions of the project lie wholly within the Rocky

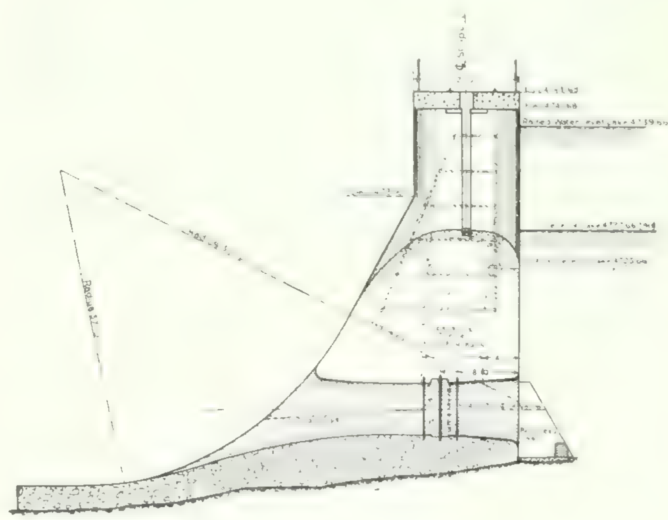


Fig. 2.—Section of Minnewanka Storage Dam.

Mountains Park and thus all water privileges, lands and rights of way are secured for the undertaking, the title being in the Crown through the Department of the Interior.

The natural water supply has been very much improved by regulating works which have been constructed just below the confluence of the Cascade River and Devil's Creek by the Calgary Power Company, Limited, under the supervision of the Department of the Interior. Primarily, these works are for increasing the water supply, especially in the winter months, to the Calgary Power Company's plants, one at Horseshoe Falls, and one more recently constructed, at Kananaskis Falls, on the Bow River, about 35 miles distant by river. It is contemplated, however, in the agreement entered into by the

Minister of the Interior and the Power Company, that this water so stored on Lake Minnewanka will be used jointly by the Calgary Power Company and the various other power users on the Bow River which may be established under future agreements with the department, the Minister having the right to control the operation of the dam.

As to the actual water supply available for power purposes, the department has taken advantage of the construction of the storage dam to secure therefrom a

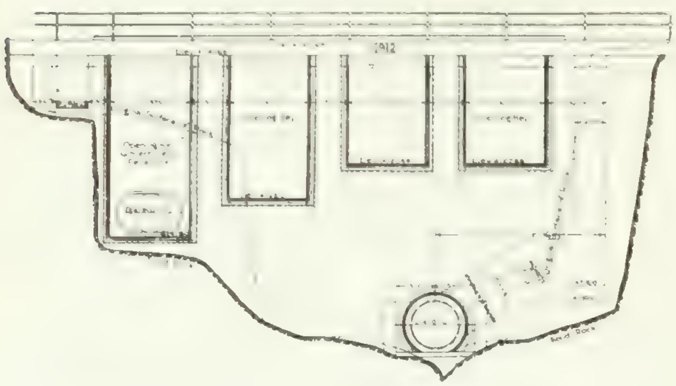


Fig. 3.—Upstream Elevation of Dam.

continuous supply of at least 150 cu. ft. per sec. throughout the year.

At those seasons of the year when the river is naturally in flood, the dam would be impounding water, but it is expected that the lake reservoir would be full to its allowable height, usually by July 15 at the latest; after that date there would be water wasted over the spillways of the dam, gradually diminishing in quantity to the end of the summer. Measurements over several years during July, August and September, indicate that at least 200 sec.-ft. can be obtained for power purposes, independently of the storage process. During the early summer this amount can readily be made available during the filling process. In the autumn months a natural supply of practically 200 cu. ft. per sec. can be depended upon, while in winter, when the storage is called upon to supply water for deficiencies, the available water under the agreement mentioned above can be increased from 150 to 200 sec.-ft. by increasing the height of the storage or lowering the level of the draw-off. Thus 200 sec.-ft. would be continuously available for 24-hour use, and the proposed works are designed for the possible use, during peak requirements for short periods under exceptional conditions, of 330 cu. ft. per sec.

Power Obtainable.—The storage dam now built has been arranged so as to provide a headworks dam and intake for securing the water for power purposes, and provides about half the total head of water contemplated in the development. The other half is in the natural fall of the river itself in the intervening distance between the dam and power station sites.

The nature of the dam, being primarily for storage, provides for the necessary fluctuation of Lake Minnewanka levels. This fluctuation, while varying the head available for power purposes, does not unfavorably affect the power to be obtained when considering the commercial side of the undertaking, because the low-water level, and consequently the low working head will occur in the winter and spring periods when the demand for power is less than at midsummer. On the other hand, when the demand will be at a maximum for this plant in the tourist season, say, during July and August, the storage basin will be filled to its maximum, and the head, and consequently the power, to be obtained will be at a maximum. As both the head obtainable and the amount of water available will both be at a maximum in July and August, when most needed, the obvious type and design is one which would have a capacity utilizing the maximum head and 200 cu. ft. of water per sec., with provision for over-development in capacity capable of using up to 330 cu. ft. per sec., as stated.

The gross head of the development with the storage basin filled to its highest level, is about 64 feet, of which

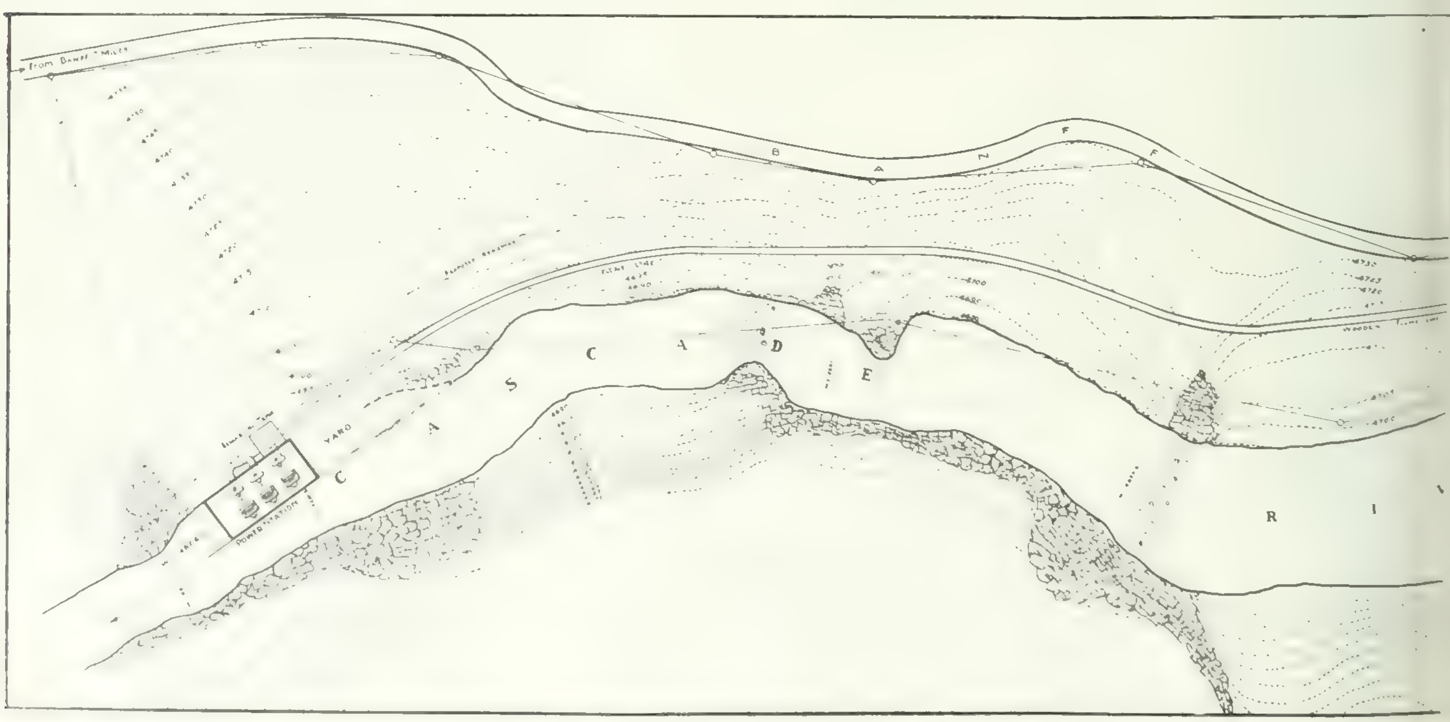


Fig. 4.—General Layout of Proposed

we compute 60 feet may be taken as the effective head on the turbines. Under these conditions, at least 1,800 h.p. can be obtained in electrical output at the power station as a maximum capacity such as might be required at "peak load" periods. This power, after transmission to Banff, will be reduced to about 1,500 h.p. net, ready for delivery to the consumers.

In order to secure this capacity of plant, it is proposed to at first construct all the general works, including the power station, to the full ultimate capacity. As, however, it is anticipated that this total amount of power will not be required in Banff in the early stages of the undertaking, it is proposed herein to place power equipment in the power station for only 2/3 of the above capacity—that is, to install only two of the three power units at present. The initial development will, therefore, provide about 1,000 h.p. in Banff.

Method of Development.—The head dam, already constructed, is at the head of the rocky canyon and is a solid concrete structure, having facilities for discharging water either over its crest through stop-log spillways or through a low level in a sluiceway closed by a gate valve. It is also provided with an intake, a stop-log opening and a forebay into which a steel penstock thimble, 5 ft. in diam., is inserted ready for connecting in the future to a penstock or flume to lead the water to the power station. This thimble has an up-stream size of 8 x 5 feet, to serve as an intake, and reduces to 5 feet in diameter, which will enable a species of Venturi water meter to be established for measuring the water used. The necessary works for the development of power commence, therefore, at the outer end of this thimble which is already in place. The intake and penstock are set at a sufficiently low level to accommodate any level of water between the limits in which the storage basin will fluctuate.

It is to be noted that with the drawing down of the water above the dam the head will be reduced, but this will occur at a season when the demand for power will not be great.

Penstock and Flume.—It is proposed to lead a 7-ft. steel pipe from the present thimble along the cliff a short distance and then enter a 7 x 8-ft. tunnel cut in the rock on the south side of the river, and emerging at the lower end of the canyon. It is not anticipated that this tunnel will need to be lined except in the bottom and sides to offer a smooth course for the water flow.

The penstock is proposed to span the canyon as a 7-ft. diam. steel pipe, supporting itself at a height about 15 ft. above the water. From this point it is proposed to carry the penstock down the north bank as a wooden stave flume of 7-ft. diam. under pressure, and set in a partial excavation. At one point this will require to be supported for about 150 ft. on concrete piers. At the lower end the flume would be buried beneath the station yard.

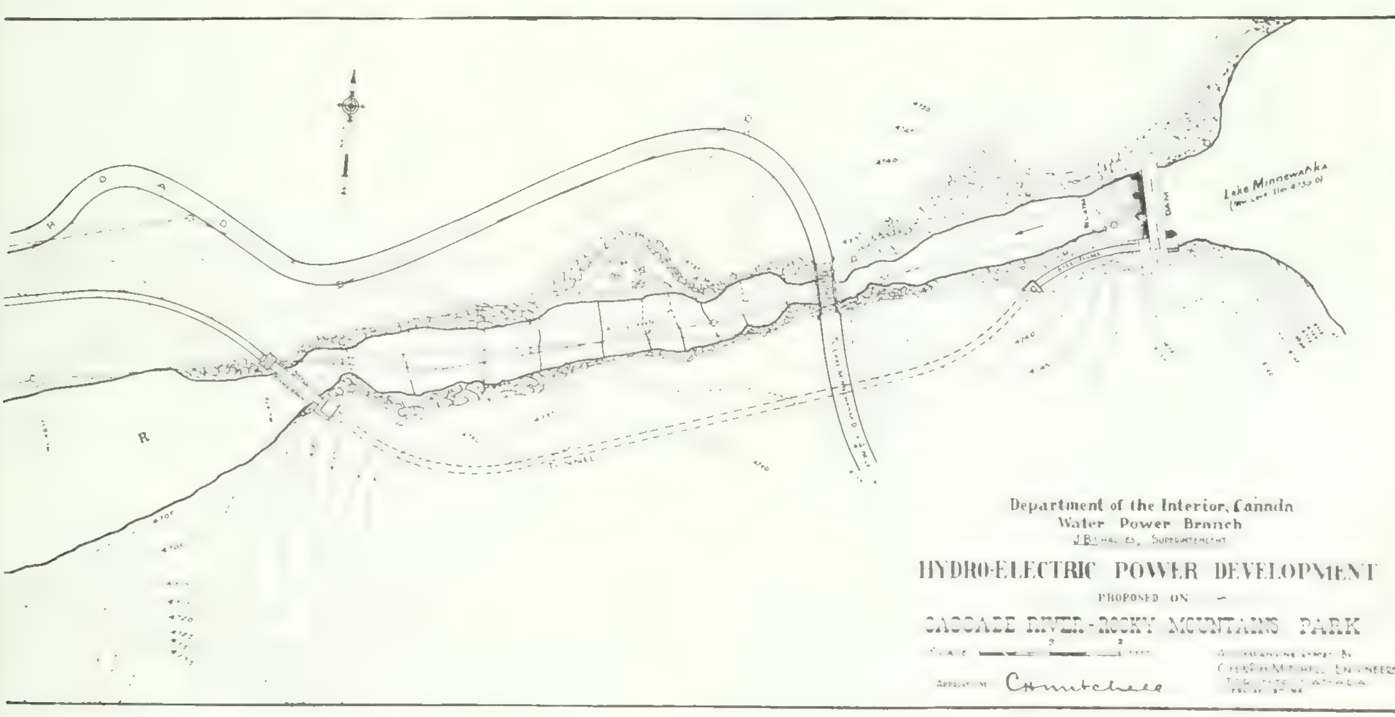
The lower end of the flume would consist of steel, 7-ft. diam., and would have three 48-in. steel feed pipes fitted with valves leading to the three power units in the power station.

In order to secure adequate hydraulic regulation through the long penstock a surge tank, 14 ft. in diam. and 55 ft. high, is proposed, having its top at about 8 ft. above the highest storage water level in the lake. It is proposed to house this tank for protection against freezing, as well as for architectural appearance.

Power Station* and Equipment.—This station is proposed to be of either concrete or brick set on concrete foundations, built entirely fireproof and adapted to continuous operation at all seasons. It is necessary to construct river walls on the outside of the station, the lower to protect the tail-race and the upper to afford a station yard and protection from any high water in the river.

It is proposed to ultimately install three power units, each consisting of a 600-h.p. turbine and a 350-kw. generator, together with an exciter unit direct connected. In the initial development it is proposed to install only two power units and the exciter unit capable of gen-

* In *The Canadian Engineer* for May 7th, 1914, there appeared four competitive architectural designs of this power station.



Development on the Cascade River.

erating of the total output of the station; the building being large enough to include the third unit to be installed at any time in the future when conditions of market warrant.

It is proposed to generate at 2,200 volts and to transmit at 13,200 volts by the use of step-up transformers. All switching and subsidiary equipment would be installed as required.

Transmission Line.—The transmission line, approximately 7½ miles long, would initially consist of one 3-phase circuit, on wooden poles. The line owned by the Canadian Pacific Railway, now in service between Bankhead and Banff, could be readily adapted to the proposed system, the only change required being the replacing of the present conductors by larger ones, sufficient to transmit 1,000 h.p.

Receiving Station and Distribution System. It is proposed to utilize the present receiving station and distributing station and equipment within the town of Banff if it can be acquired at a reasonable price. This system is in excellent condition and is usable with modifications in any extended system of distribution and lighting in the town. As it is proposed in connection with the new system of lighting contemplated in the town and vicinity to extend the distribution system very considerably, it will be necessary to construct several miles of new lines, the wire for which can be secured from the transmission line.

In order to carry out a suitably extensive project of lighting the town and vicinity in an attractive manner, utilizing the most up-to-date types and arrangement, it will be necessary to rearrange the present system and to extend it.

It is proposed that a 3-phase system would encircle the centre of the town, having 3-phase feeders radiating from it. It is expected that the 3 phase lines will prove ample for the complete distribution of power for industrial power service, domestic and commercial lighting and heating to the full commercial output of the generating plant.

A very attractive street lighting system is proposed and special lighting units have been designed. The lighting plans, as at present arranged, provide for 40 standards, 278 bracket lamps and 18 path lamps. Some of the streets will be provided with underground wiring. Street lights will, in general, be operated by the same transformers as are to be used for house lighting, clock switches being installed to operate individual sections of the system at predetermined hours. The lamps indicated on the plan will consume about 120 h.p.

Power Supply and Distribution.—The capacity of the power and transmission system outlined in the foregoing as an initial system of 1,000 horse-power, laid down in Banff, is amply sufficient for some time to come for all the lighting that may be desired, and at the same time will provide power for those various small uses such as motors in bakeries, laundries, printing offices, butcher shops, small machine shops and mills, etc., and for heating.

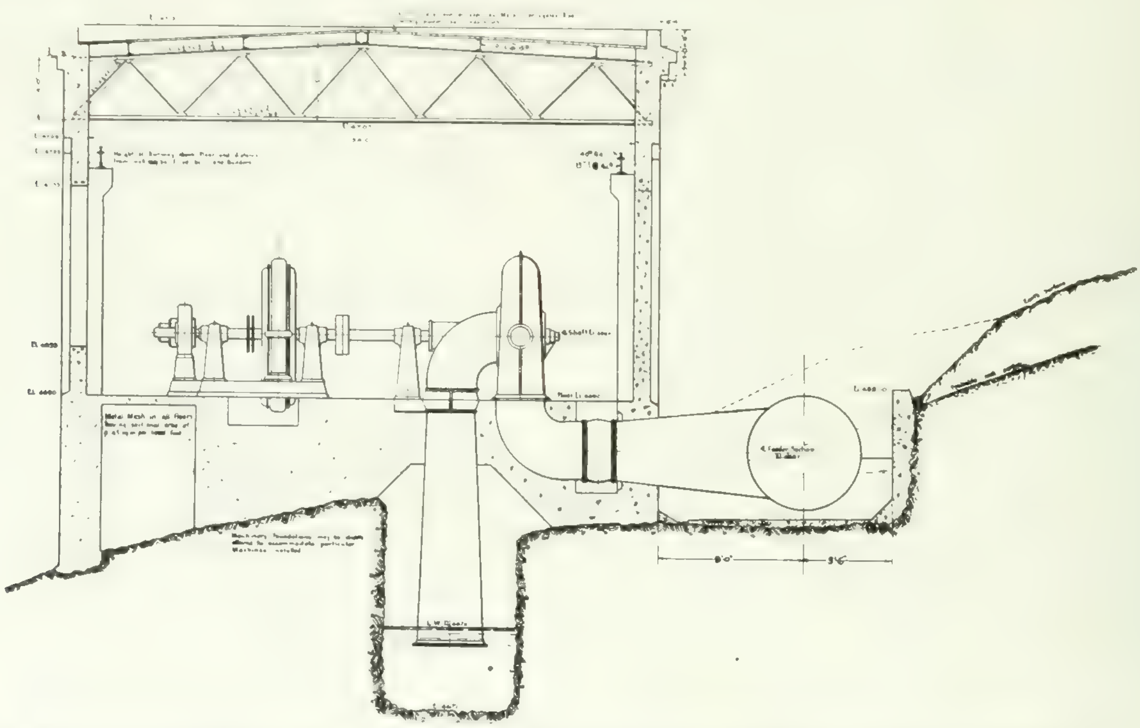


Fig. 5.—Typical Section of Power Station of the Proposed Cascade River Power Development.

Estimates of Cost.—In the following, estimates of cost of construction are based entirely upon the construction of a new system complete from the dam (already built) to, and inclusive of, the distribution and lighting system outlined, as it is only on such a basis that the comparative costs can be readily considered.

The following estimates are based upon the current prices for labor, apparatus and supplies provided and delivered at the location required. If construction is undertaken under conditions whereby these current prices are visibly exceeded, the estimates herein given must be correspondingly increased.

The following estimate is for general works for the whole ultimate plant, but with hydraulic and electric machinery installed only sufficient to deliver 1,000 h.p. in Banff:—

Penstock and flume, including headworks connections, tunnel, river span, wood flume, feeder section and rising section complete ready for water	$34,000.00
Regulating tank, including housing	1,000.00

Power station; foundations and buildings complete with interior work and fittings	12,000.00
Staff house and miscellaneous	4,000.00
Equipment in power station, consisting of hydraulic and electric equipment sufficient to deliver 1,000 h.p. in Banff, together with all subsidiary machinery, such as governors, switching, piping, fittings, etc.	35,000.00
Transmission line complete, total length about 7½ miles, capable of transmitting 1,000 h.p.	11,000.00
Distributing system in and around Banff, comprising receiving station and shop, step-down transformers, town wiring, street fixtures and transformers, the whole leading up to all lighting connections but no lighting	17,000.00
New street lighting system complete, including 60 five-cluster lamp sets and posts, and 250 bracket lamps on poles, together with underground wiring for clusters	10,000.00
Total	$124,000.00
Add for contingencies, engineering supervision and inspection, 12 per cent., say	14,000.00
	$138,000.00

Annual Cost of Operation.—Assuming that (as if for a private company) the funds for the construction and installation of these works were raised by a debenture issue, say, of $140,000 at 5 per cent. to be retired in 30 years, and that the principal and interest is repaid in thirty equal annual instalments. The annual costs of operation and maintenance of the plant throughout will be approximately as follows:—

I. Overhead Charges:

1. Yearly instalment of principal and interest, based on foregoing	$9,100.00	
2. Maintenance account, being an amount set aside yearly against major repairs, renewals and reasonable extensions, 2½ per cent.	3,250.00	
		$12,350.00

II. Operation Charges:

1. Salary, superintendent and general office expenses (within park office)	$2,200.00	
2. Wages of operators at power station	3,000.00	
3. Supplies and minor repairs chargeable to income	1,250.00	
		$ 6,450.00
Total annual cost		$18,800.00

If the foregoing annual cost of operation and maintenance is placed against the total amount of power capable of being delivered by the plant in Banff, viz., 1,000 horse-power, the annual cost per horse-power (24 hours per day) laid down in Banff is approximately $18.80. It is to be noted that steam-generated electric power laid down in Banff in the same manner as hydro-electric, using the usual types of engine under ordinary economic commercial conditions, would, on the same basis, in our opinion, cost not less than $50 per horsepower per year, even with cheap coal nearby.

AN ICE COFFERDAM.

The following practical application of the idea of using ice as a cofferdam in connection with construction work during the winter in climates where low temperatures prevail is cited by Lieut.-Col. Chas. L. Potter, Corps. of Engineers, U.S.A., in "Professional Memoirs" for June, 1914. On a previous occasion the writer had attempted to employ the same method in connection with the construction of the foundation for a small light in shallow water at Lake Memphremagog, but the time had been too limited to effect the freezing. The attempt described below, however, was quite successful, and should contain a suggestion or two for those who have work of a like nature to do in times of low temperatures.

The United States dredge "Warroad" was repaired at Kenora, Ont., in 1912. After being put in the water, a leak showed on one side about 3 feet below water-line. It was not bad at the time; the dredge was needed for work; and the leak was allowed to go. On the laying up of the dredge for the winter of 1913-14, it was decided to try the ice cofferdam method to repair the leak, which was giving considerable trouble.

Owing to the possible necessity of replacing an entire plank, the work was done on a much larger scale than proved to be necessary. On January 25th ice was 18 inches thick in Warroad Harbor. A trench was made 20 feet long, 3 feet wide and 12 inches deep alongside the dredge. Thereafter each day, when the thermometer had been below zero the night before, 1 inch of ice was cut out of the bottom of the excavation. Days when the thermometer was not higher than + 15 degrees during the entire day, there were taken out 1½ inches. After each day's work a small hole was bored to a depth of 5 inches, and dry wooden plugs kept near to plug the holes in case the bit broke through, but it never did. The rate of cutting and the means of insuring a thickness of 5 inches in the bottom of the trench were determined by the custodian of the dredge, as he had no instructions except to get down to the leak. It is probable that he might have gone down somewhat more rapidly, but he was present every day in care of the dredge and there was no occasion to hurry. Parties harvesting ice at that time found that their ponds, left open at night, were frozen about 2 inches during the coldest nights. During the operation, the maximum daily temperatures ranged from + 30 degrees to — 15 degrees and the minimum from + 6 degrees to — 47 degrees. Only once was the minimum above zero, and the maximum was below zero for five consecutive days.

On February 24th—exactly thirty days—there was a trench 20 feet long, 3 feet wide, and 34 inches deep, with 6 inches of ice in the bottom. The thickness of ice in the vicinity was 24 inches. So we had gone down 10 inches below the bottom of normal ice; we still had 6 inches under us; and had uncovered the leak 34 inches below water-line.

The repairs amounted to nothing more than cleaning out a small split in a plank and caulking it.

Mr. H. R. MacMillan, Chief Forester of the province of British Columbia, recently made the announcement that a deal in standing timber in the neighborhood of Fort George has just been carried out by the Government sale to Mr. H. N. Sereth, of the Riverside Lumber Company, of Calgary, of 32,000,000 feet of lumber at the following prices:—Douglas fir, $2.54 per 1,000 feet; spruce, $1.07 per 1,000 feet, and cedar, $1.06 per 1,000 feet. The total value of the timber reaches $37,000, the purchasers to cut this within the next two or three years.

USE AND BENEFITS OF PRESSURE RECORDING GAUGES.*

By J. M. Diven.

RECORDING gauges for keeping a permanent record of steam and water pressures and vacuum have been used by waterworks for many years. In 1891 Mr. Charles A. Hague, in his introduction of his valuable paper entitled "Value of Pressure Records in Connection with Waterworks," said that we should know what is going on inside of steam and water pipes, just the same as we have found out what is going on inside the steam cylinder by the use of the indicator.

In his paper Mr. Hague quotes Mr. Edwin Darling in his 1889 report of the Pawtucket, Rhode Island, waterworks, as follows: "No well-conducted waterworks can afford to be without recording gauges, and, when properly located, they will, in my opinion, pay for themselves within one year" (Proceedings Am. W. W. A., Philadelphia, 1891, p. 77).

These extracts go to show that the value and usefulness of recording gauges were fully recognized more than twenty years ago. We certainly do need to know what is going on inside of the steam and water pipes under our charge, and at all times. A look at the non-recording gauge shows us the pressure at that time, but is no proof or indication of what it was a minute before. The recording gauge does give this information; it tells what the pressure was at any time, day or night, and on any date. It is a constant watchman, just as a water meter is a constant inspector. It keeps a complete and indisputable record of pressure at all times.

In the Pumping Station.—A recording gauge on the steam line is the best possible check on the work of the fireman and engineer. If pumping to a reservoir, under a constant load, the uniformity of the pressure line tells how uniformly the fires are being tended and the feed water applied. An absolutely even line would indicate perfection in the fire room, a ragged line, inattention on the part of the fireman. With properly kept boiler room records, the fireman's work can be accurately checked. A sudden drop in the pressure line should correspond exactly with the record of fires cleaned or boilers blown off. A quick drop or sudden rise at any other time indicates improper firing.

With a direct pumping system, or where pressure has to be raised for fires, a less even steam line is to be expected; but a comparison of the steam and water charts will show how quickly the boiler responds to a sudden demand for more water pressure, by restoring and holding the pressure when the work of the pumping engine is suddenly increased. A direct pressure pumping system requires greater care and alertness on the part of the engineer and fireman, and the recording gauges are the best possible means of knowing how well they perform their work. Perfection would mean a line equal to one drawn with a compass or straight edge, according to the style of chart used, and the nearest approach to this indicates the best work. A ragged, zigzag line means inattention and carelessness, or something wrong with the boilers, steam lines, engines or pumps. It rests with the chief engineer or superintendent to find out which is at fault, and to correct the fault; the gauges cannot do this, they can only tell in positive language that something is wrong.

The presence of recording gauges is an incentive and stimulus to the men to do better work. They know that they are constantly watched; that a constant and indisputable record is being made of their work. The superintendent, when he visits the pumping station, or when the gauge chart is placed on his desk, has a perfect check on the work of the pumping plant force, and a record he can preserve for all time. When he has occasion to call an engineer or fireman to account for laxness, he has before him, to confront the culprit with, an undeniable record of his work. A poor pressure line may not be the fault of the engineer or fireman; it may be due to poor fuel, a leaky or sagging steam line, bad feed water, poor draft, or engine trouble; but the engineer is just as much at fault, for not promptly recording and reporting such troubles, as he would be for neglecting his work, or not keeping the fireman up to his part of it.

If good pressure charts are obtained for a while, but constantly and uniformly get bad, it indicates either that the plant is wearing out or being overloaded. If both good steam and water charts are obtained when the plant is pumping, say, 5,000,000 gallons a day, and grow more and more ragged as the pumpage is increased, they surely indicate that the pumps or boilers, or both, are being worked beyond their economic capacity. If the pressure lines grow in irregularity, when there is no increase in the work, they indicate that some part of the plant is wearing out or is in bad order, and needs overhauling.

Steady lines of the steam charts indicate uniform and careful firing, and a steam plant in good condition. Ragged gauge lines indicate either poor and irregular firing or bad condition of the boilers. If the feed water is a scale-forming water, the poor gauge lines bear out the evidence of the coal scales, that the boilers need cleaning.

A fireman cannot fill his firebox, then light his pipe and go out of the fire room to seek a cool place, and maintain an even line on his steam gauge charts; but must stay by his fires, fire frequently and lightly, and keep clean fires. Knowing how completely he is on record he will be careful, and will also keep a record of everything that might affect his record, such as poor fuel, time of cleaning fires, blowing off boilers, etc. The latter records, which might otherwise be neglected, are in themselves of sufficient value to more than pay the cost of the recording gauges, if no other benefits were obtained.

The vacuum gauges should also be recording, to indicate the condition of the engines and pumps, a falling off in the height of the vacuum line indicating leaks that mean more coal. The lines on the vacuum gauge charts should not vary much. If a vacuum of 27 can be obtained one month or year, it should be maintained the next month and year. If a higher vacuum is maintained with one kind of packing than with others, the one holding the high vacuum is the best, and probably the cheapest, though much higher priced than the others. The difference in cost might be made up many times in the saving of fuel.

No engine room is complete without at least three recording gauges, as the operation of the plant cannot be properly checked and governed without them. They also insure better work on the part of the operatives.

Many times the recording gauges create a spirit of rivalry between men on different shifts, through an effort on the part of each shift to do better than the others, to show more even lines on the charts; thus causing all to do better and more economical work.

There should be a certain economical relation between the steam pressure and the water pressure. When this is

*From the March, 1914, Journal of the American Water Works Association.

worked out it should be as closely maintained as possible. An unnecessarily high steam pressure, even though it gives a very uniform gauge line, is not economical.

On the Distribution System.—On gravity supplies or pumping plants, in cities of considerable size, a gauge, or gauges, should be placed on the distribution mains at some central point, or at typical points. If more than one service, high and low service, each should have a recording gauge. It is well, when practicable, to take gauge services off of large or leading mains, where they will not be liable to the great fluctuations in pressure frequent on smaller distribution pipes.

Of course, there should be a gauge in the office, where it will be under the eye of the superintendent when in the office, and, at other times, of some other officer or employee of the waterworks, of the night watchman, if one is employed; one in the superintendent's house, for reference at night, is convenient, but, with telephone connections, not so necessary.

The connection to the gauge should be entirely independent of all other service to the building in which it is located. It should be of good size, not less than ¾ inch, and placed where it will be in no danger of freezing, as there cannot be a circulation in the gauge service and an accurate record of pressure on the main at the same time, without the expense of a double service, in which a free circulation would be doubtful, unless it were very carefully planned, and even then there would be an item of friction in the smaller pipe, that would be difficult to account for. Of course, water cannot be allowed to run in the gauge supply pipe, in cold weather, without totally destroying the value of the gauge record.

The gauge service should be so arranged as to be easily blown out or flushed, to avoid all possibility of stoppage, by an accumulation of sediment. While a ¾ inch or larger service is recommended, the gauge operates with a very small opening; the object of the large service is to avoid stoppage.

Location of Gauges.—The pumping station gauge comes first, and, in smaller plants, is all that is required. Larger plants should also have an office recording gauge. Cities or towns with two or more services should have a record on each service. Large cities should have recording gauges at various points on the distribution system, notably near the congested value districts.

Gauges can be placed in the residences of employees of the works. They require little attention, winding of clock, changing of charts, and seeing that the pen, where ink records are made, is kept properly filled.

The fire department stations are convenient places for recording gauges, and the fireman's interest in the water pressure is enough to insure proper attention. For municipal plants, police stations can be utilized, if they are better located than the fire engine houses, that is, on larger supply mains.

Very long services should, naturally, be avoided, both on account of the expense and the danger of stoppage in long lines of small pipes. The service should be of durable material, and, with corrosive waters, iron services should be avoided, as an accumulation of iron rust would stop up the minute orifice of the gauge.

The Benefits of Recording Gauges.—The benefits of recording gauges are many; they have been known to stop law suits, where actions for damages caused by low pressure were threatened. The recording gauge settles many disputes concerning pressure at time of fires or other times. Often complaints of low pressure are made, not enough to supply the upper floors of some buildings. A nearby recording gauge demonstrates that it is a local trouble, within the building. These complaints are frequently that the pressure is low at certain hours of the day or night, but a gauge chart showing a uniform pressure at those hours, demonstrates that it is local use of water, in the building itself, or in the distribution system near it, that causes the trouble.

The recording gauge charts show the effect of cold weather on the water supply, the low pressure lines on the chart in freezing weather indicate the extent to which water is being run to prevent freezing. They also reflect the hot weather use of water; a low pressure line on the chart at night tells of water allowed to run on lawns all night.

Portable Recording Gauges.—All parts of a city cannot at all times be covered by recording gauges, so that the story they have to tell is incomplete. Portable recording gauges set up in various places for short periods make a fairly complete record of the conditions of the supply at points on the distribution not covered by regularly established recording gauges. Such records in large buildings, factories, etc., where the fire hazard is great, are particularly useful.

A gauge set up for a single day gives a valuable record, as it shows a comparison between the day and night pressure at some particular point.

Portable gauges can, with advantage, be connected to fire services, as, on such services, they would be free from the fluctuations due to the use of water on the premises, or, if the fluctuations existed, they would reveal improper use of water from the fire services. With a small portable house or box to protect them, gauges can, in warm weather, be attached to fire hydrants, to make a record of the pressures on the mains at any point. Summer records of this kind, made on the outlying mains, mains in sparsely built-up parts of the city, on long runs of small distribution pipes, and on the outskirts of the town, are of great value and interest.

Preservation of Gauge Charts.—Charts should be permanently kept as a part of the records of the works; as part of the history of the plant. They should be conveniently filed for reference at any time. For straight line charts suitable albums or scrap books make a convenient file. For round charts the scrap book form, though suitable and convenient, is bulky, as a page would be required for each day's chart. Substantial pasteboard boxes of the right size to hold a year's charts, are convenient. These can be labelled with the year, and, where several recording gauges are in use, with the location of the gauge, making it convenient to refer to the charts from any gauge at any time.

It is interesting to look over the old gauge charts, also often instructive. A new waterworks, with new and clean pipes, with pumps not over-crowded, and ample size force and distribution mains should show a steady line, with slight fluctuations, and near the outer edge of the chart. As the consumption increases, the line grows less and less steady, and converges toward the centre of the chart, showing the reduced pressure due to greater friction in the mains. The raggedness of the pressure line on the chart also increases with the age of the plant, as the mains become tuberculated and clogged with sediment. Finally, the consumption has gone beyond the pump capacity; a new and larger pump is installed, and the pressure line again approaches the outer edge of the chart, and becomes more steady, but still shows greater fluctuation than when the plant was new and working at a comfortable rate.

Notwithstanding the new pumping engine, the results are not entirely satisfactory, when compared with the

earlier charts; the pumping engine, though of ample capacity, is working harder than the original pump had to work; both the water and steam pressure lines on the pumping station gauges have approached nearer to the outside circles. Higher water pressure has to be maintained on the pumps to keep up the pressure on the distribution mains. A comparison of the gauge charts from year to year shows this steady gradual increase of the pumping station pressures, and, at the same time, lessening of the pressure at the office and other points on the distribution system. Finally, the pumps are unable to give a proper pressure in the town though they have a capacity even greater than the demand. A new force main is installed, and the original conditions are nearly restored, though the pressure lines are not quite as steady as at first, owing to bad condition of the pipe system. A thorough cleaning of the mains and distribution pipes restores the steady pressure line near the outer edge of the circle. So, the gauge chart tells us when a new pumping engine is needed, when to install a larger force main and feed mains, when the mains need cleaning.

A study of the old gauge charts tells a story, relates a plant history, as old documents or old letter files tell the story of the community. This is especially so if the charts are carefully and properly labelled before they are filed away; the date, the temperature and weather conditions, notes concerning fires, breaks in mains, engine or steam plant troubles, etc.

A frequent examination of the files of old charts should be made, as they tell an interesting and valuable story of the operation of the works, and give valuable hints for needed changes and improvements.

There is now an instrument for ascertaining from the pressure lines on circular charts, the style now mostly used, the average daily or weekly pressures. These results can be conveniently plotted, so as to show compactly the average pressures throughout a year, or many years. The plotting of two or more years on the same sheet, using different colored inks for the different years shows compactly the comparative pressures for the equal seasons of each year. Temperature and weather condition notations would add to the interest of these charts. For instance, the month of February in one year shows a steady and good pressure line, while the same month of the next year shows low pressure and a ragged line. The temperature reference shows for one year a moderate temperature, for the other steady cold weather with extremely low temperatures. Without the temperature record the great difference in pressure would be hard to explain.

Consumption records should also be included, to account for the probable steady decrease in average pressures from year to year. Like the February temperature record, the mid-summer temperature and precipitation records would also tell their story.

Recording gauges are useful in so many ways, give so much information and so good a record of the daily operation of the pumping plant and the condition of the plant, that they are indispensable, and no well-regulated waterworks should be without them, and none can have too many. A superintendent cannot have accurate knowledge of the operation and condition of the plant under his supervision without using pressure-recording gauges. It is false economy to try to do without them. The cost of installation and maintenance is small, trifling, as compared with the benefits.

Pressure-recording gauges require little care, if daily charts are used, and they give the best records—daily changing of the charts, winding the clock, and filling the pen, are all that is necessary. The supply pipe should be blown out occasionally, to keep it clean, and the clock kept regulated, so that the time records will be accurate. This last item is important, should disputes arise, concerning pressures at time of fires, particularly in towns where an increased fire pressure is required. The rise of the pressure line in the chart should disputes arise, concerning pressure at time of fire alarm. In this connection, some care must be exercised in placing the charts, to see that they start on the correct time line. Some troubles have been caused by carelessness in this, occasionally, for some unapparent reason, the gauge chart does not revolve, though the clock is going. This may be due to careless securing of the chart, or to putting in two charts at once, the under one revolving all right, but not receiving the impression of the pen or pencil, the outer one slipping on the smooth surface of the lower one and remaining stationary.

DANGERS OF ACETYLENE GAS

"That acetylene gas lighting plants require most careful handling and that no such plants should be installed or maintained in the basement of any buildings—these are the lessons taught by the recent catastrophe at the hotel at Macoun," says Fire Commissioner R. J. McLean, of Saskatchewan, in a recent bulletin.

Hitherto too large a measure of indifference and consequent carelessness have existed in regard to both gasoline and acetylene. No more than a passing thought has been given to the explosive qualities of either and whether location of such plants inside buildings materially affects the risk of life and property has received scant consideration.

In view of this disaster public interest has been aroused and advantage is taken of the opportunity by the office of the Saskatchewan fire commissioner to indicate the nature and danger of acetylene. Its advantages as a light in cases where electricity is not available are undoubted. Amongst them are the following: The light is brilliant and colorless, the flame gives off less heat and poisons the air less, its odor is so strong as to be easily detected, its vapor is so light as to be readily dissipated, the bore of the burners is so small as to permit very little of the gas to escape.

On the other hand its dangers are so great as to demand the strictest precautions as to the conditions of generator, storage tank and piping and also to location of these. As a gas it is so highly explosive that air containing one-thirteenth as much acetylene is more explosive than gunpowder. Acetylene is produced by the union of calcium carbide and water. The water may be fed to the carbide or vice versa, but feeding the carbide to the water is much safer. In either case any generation or superfluous gas, due to lack of feed control, is highly dangerous. The danger is generally near the generator. A defective feed tube or the opening of a seam, caused by the freezing of the water seal, may cause an escape that has only to come into contact with a light, a red hot cinder or even a pipe in a smoker's hand to do more harm than dynamite.

Should an acetylene generator—or even a gasoline carburetor—be permitted in any basement of any home or public building? is the question which is being asked to-day, and the answer is, No, any such installation is not advisable. All such generators should be placed outside at a safe distance. Whatever difficulties may arise as to the methods of heating such outside buildings—an acetylene machine will freeze if placed in a building that is not warmed—are such as should be overcome at all costs as compared with the danger of having an inside installation. It is better to be safe than sorry.

The Macoun disaster cost ten lives and as many injured and the absolute destruction of $35,000 in property. A leakage from an unknown cause, coupled with the presence of a fire in the furnace or an open flame in the same basement was the origin of the explosion. There are many homes, churches, and public buildings in Saskatchewan lighted by acetylene. No thought is given to the danger, and no thought was given to this sad case. An appeal is hereby made for safety first and safety all the time. Consider the danger to human lives and property and guard against it.

POINTS WORTH NOTING IN CONNECTION WITH ROAD IMPROVEMENT.*

By Major W. W. Crosby,
Consulting Engineer, Baltimore, Md.

WHEN the improvement of a locality's public roads is begun on comprehensive lines and according to some definite scheme, several important questions immediately present themselves for consideration and decision. Among them are:—

1st. The selection of the roads to be improved, such a selection being necessary for obvious reasons.

2nd. The organization of the administrative and executive forces under the laws governing the work.

Too often the speaker has observed an apparently insufficient comprehension of the importance of this latter question—perhaps more especially in those cases where an existing organization, developed for carrying on certain limited operations, was suddenly loaded with the new work in an amount several times as great as the earlier burden. In such cases it has been too frequently the practice to attempt to expand the old organization, by adding new units of the same character to it, so as to carry on the new work when what should have been done was to recognize the different character of the new work, its preponderance perhaps, and its peculiarities from any point of view, and to recognize the entire department so as to provide such a machine for the combined operations as would properly and efficiently produce the results desired. It is coming to be realized—possibly through the good results obtained from some efficiency experts—that proper organization is necessary for successful results, especially when large scale operations are to be attempted, and that it is futile to attempt to secure efficiency simply through the multiplication of units. Proper co-ordination or relations between the units must be provided, and the units themselves must each be composed of the best quality of the available material so arranged as to work successfully and without constant failures.

3rd. The selection of the methods and materials to be used in the work itself. The importance of this question can readily be appreciated, but perhaps a word or two on it may not be out of place here. In almost any locality the opportunity is offered for a choice between two or more methods and materials for improving a road surface. Now, while with money raised by annual levies, considerable latitude in the expenditure of such funds may seem to exist, such is not the case with borrowed funds. In the one case it may be said that it is the "income" which is being spent while in the other it may be said to be the "principal." It is at least not as extravagant to spend one's income for things of a temporary nature as it would be to waste one's principal on them. Therefore, in the expenditure of borrowed funds for road improvement every effort should be made to secure results that will prove of the greatest possible permanence and cheapest in the long run—not necessarily cheapest in first cost. On the other hand, it is useless to look for a "permanent" road, if by the expression is meant a road that will not require yearly expense for its up-keep. In the historic words, "There's no such animal." All roads need maintenance, and in calculating the cost of a road, this expense for maintenance must be added to the interest on the first cost in order to secure figures which will enable a comparison to be made on a monetary basis between the value of the results from two differing methods or materials of construction. It will only too frequently be found to be the case that mistakes from the point of view of expense have been made by the vain attempt to secure, regardless of first cost, a "permanent" road surface and that a saving would have been made had a cheaper surface been laid and replaced as needed from time to time. This is especially true where traffic conditions are in a changing state. On the other hand, it must be remembered, as before referred to, that the other extreme of cheapest first cost may be equally undesirable as a refuge for the solution of the problem.

Good location of the road, satisfactory grades for it, sufficient width of right-of-way, substantial and enduring bridges and culverts, proper drainage and adequate foundations are some of the most permanent features of modern road work. They should be had at almost any cost from borrowed funds, and by securing them the borrowing of money for the work is best warranted. For the road crust itself to be placed as a wearing surface over such basic items, excessive expenditures from borrowed funds are neither warranted nor logical. But if borrowed money has to be used for these wearing surfaces, then every effort should be made to secure in its expenditure the greatest possible value in the long run for the results. The term of the bonds, the future of the traffic, the availability of materials, the probabilities as to maintenance, etc., etc., will all affect the decisions in any case, but perhaps enough has been said to indicate the complexity and importance of this question.

Just at this point it seems pertinent to the speaker to offer a word or two more on a closely related point to which reference has been made. If not already an accepted axiom, it should be that no bond issue for road improvement should be made unless the proper maintenance of the physical results of the bond issue is amply provided. Of course, that the expense for maintenance should in no case be met by borrowed funds needs no argument here. The probabilities for maintenance—that is, consideration, of the needs for and sufficiency of the funds for this work, of the probable promptness and thoroughness with which it will be performed, and of the character of the authority over it—are bound to influence decisions in the matter of the selection of road crusts to be built. If maintenance funds are for any good reason bound to be insufficient for properly keeping up one form of crust, then it will be necessary to incur the greater expense for first cost of a form less expensive to maintain, even if the long run cost be greater, because unless the road crust is to be so maintained as to give its greatest possible value, there is no excuse for putting any borrowed money into its construction. If the maintenance to be expected is not to be prompt and thorough, then the need for attention to up-keep should be reduced as far as practicable by modifications in construction. The culverts and drains may thus have to be built larger than they otherwise need be if they were to be kept continuously free from obstructing matter. If the maintenance is to be turned over after construction to a body other than that in charge of the construction, allowance should be made in the solution of all construction problems for the probable lessened interest of the second body for the proper up-keep of the construction done by other parties.

A paper on each of the questions referred to above might well be presented for the consideration of this audience, but while the speaker was given considerable leeway in his selection of a subject and has thought it advisable to refer briefly to these matters as preliminary to the subject indicated to him as especially desired from

*Read at First Canadian and International Good Roads Congress, held at Montreal, May 19th, 1914.

him, he will leave to others further dilation on the points mentioned and proceed with the question:—

4th. The securing of proper work in the construction itself. The speaker does not intend to attempt to cover all the points on which remark might be made but merely to point out and to explain as may seem advisable such points as are not usually covered by specifications or are of especial importance and, to him at least, worthy of further emphasis. Furthermore, it may be that some of his remarks may seem to be out of place under this topic and that they should have been made under the preceding headings. In such case he asks the indulgence of his audience for the apparent disorder, but hopes that a further reason for his introductory remarks may be apparent.

In the construction of macadam roads—using the term "macadam" in the broader sense of meaning a road-crust composed of gravel, broken stone, or slag within certain limits of size, thoroughly compacted before any fine material shall have been added, and then having its voids filled with fine material or "bound" by the combined action of watering and rolling with the addition of only the needed amount of fine material such as sand, stone dust, etc.—it is generally specified—but less generally practised—that the "subgrade" or earth surface, on which the macadam is to be spread and built, shall be made firm and even before the macadam material shall be spread. The importance of this specification is often not realized by inexperienced engineers and contractors. To the former the clause seems frequently to be cautionary and not mandatory, while to the latter it generally seems fussy and unnecessary. To both, as well as to you, the speaker would say that this clause is important and absolutely necessary. Unless it is carefully observed the contractor will have trouble and extra expense in performing his subsequent work of compacting his macadam and the engineer will not be able to secure the results specified and desired for the road-crust.

An improper subgrade will mean that an excess of macadam material will be needed in order that a clean compact layer of macadam of the minimum thickness required for strength shall be finally had. It will mean greater difficulties in rolling the macadam and may even prevent the proper degree of compaction from being secured and thus the presentation of an inferior article for acceptance and use. This, of course, means shorter life, increased maintenance expense and greater waste of borrowed funds in a channel of doubtful, or at least questionable, use of such funds. If the subgrade is left so loose or soft that it is forced up into the macadam material during the rolling of the latter, any hope of securing macadam from this material is lost and the broken stone, gravel or slag under such circumstances can only be considered as an addition to the subgrade—and quite likely an unnecessarily expensive one—on which a macadam or other crust may eventually be built.

The same remarks concerning the necessity for a firm subgrade in the case of gravel roads where the crust is composed of suitable unscreened gravel, though in the latter case the fine material present with the stones may help somewhat to overcome the dangers incident to placing the gravel on the soft subgrade. Even with concrete road crusts and foundations, it is now generally agreed, for the sake of better and more lasting results, that it is desirable to have as good a subgrade as practicable.

Another point that is too often slighted in connection with macadamizing is the proper rolling of the macadam material. It is usually specified that the rolling shall proceed until the material shall be thoroughly compacted, firm, and even on the surface or until waving ahead of the roller is imperceptible. An old rule for the guidance of inspectors is to have the rolling continued until the material is so firm that no movement in it is discernable adjacent to, but outside of, the fact as one walks over the rolled surface. The speaker has found too often a tendency among inspectors to require too little rather than too much rolling, and of course the average contractor's foreman will yield to, if not actually encourage, this tendency to slight the rolling. Perhaps, therefore, a word or two of explanation as to why sufficient rolling should be done may tend to bring better results. When broken stone, for instance, is spread on the subgrade from piles on dumping platforms or piles alongside the road, the voids in the stone layers are approximately fifty per cent. of the mass. It is obvious that the denser the layers can be made the better wearing surface will be produced. By proper rolling the original voids can be reduced by forty per cent. (or to 30 per cent. of the mass) though to secure this result the rolling must be had before the addition to the screenings. The addition to, or even the presence of fine particles in, the macadam material before the rolling of the latter will interfere and often prevent the desired compaction being secured.

The tendency of most contractors' foremen is perhaps naturally to roll insufficiently the macadam material and then to attempt to secure a bonded surface by the addition of fine material and water with more rolling. The results of this process can but be inferior to those secured from the same materials but with proper rolling before the addition of the screenings. It should be understood that the rolling of the macadam material does something more than compress the layer. Properly done, the rolling not only compresses the layer but it also works the pieces of stone together so that the angular pieces fit into the voids of the mass and mechanically interlock, thus strengthening the mass against a tendency toward displacement. Further, under proper rolling the stones at the surface at least are disposed so as to present to the wear of traffic a flat side instead of an edge and consequently to sustain better the wear coming on them. These facts explain the better wearing qualities so noticeable in macadam built with a minimum of fine material and the inferior quality of an old-fashioned "stoned road" where the crust was probably unrolled and the coarser pieces are merely set in a matrix of mud like plums in a pudding.

It has been said, "First get your coarse material (meaning that forming the body of the road crust) where you want it and then fill the voids remaining with the filler to be used in any case." Doing so may account for the already recognized greater strength of rolled and grouted concrete over that of mixed and placed concrete.

One more thought on construction details is concerning the application of the fine material. It is desirable from many points of view, some of which have been mentioned, to keep the amount used to the minimum necessary. The better way to do this is to apply it in thin layers and only as many of them as evidently needed. The application of a single thick layer means the formation of a temporary cushion which interferes with the proper filling of the voids in the macadam and its final bonding by the aid of water. After the macadam has been thoroughly rolled, a thin layer of fine material of the proper character should be spread and then rolled and watered. Bare places then appearing may then be covered again with another thin layer, and so on until the road is finished. If, then, an excess is desired for any reason to be left on the surface, it can readily be applied.

but if an excess has been first applied, the removal of any part of it, no matter how desirable, is difficult, if not impossible.

The speaker has referred, in his remarks on the work of construction itself, mainly to macadam roads because it seems to him that the bulk of the work in view is probably of that character. Occasionally one hears that "macadam is a thing of the past," but this is, as the report of Mark Twain's death was at one time in his words then, "an exaggeration." M'Adam's principles will be in use for many years yet, and good macadam properly built will be the economical road crust for many localities for a considerable future period. If necessitated by conditions, it can be treated in one or more ways with pitch or pitch compounds, so that its availability is widely extended. But its underlying principles still prevail, hence its selection by the speaker for limited time of his remarks on this point.

The expenditure of large sums of money on a section of road or of any borrowed money for road improvement is based on the single principle that an investment is thereby made which will return a profit to the ratepayers. There is no other excuse for the expenditure of more funds than is necessary to preserve things.

The profit may be direct, indirect, or both. It may often be that such expenditure as the installation of necessary drainage facilities will permanently reduce the annual cost of maintenance. This is a direct financial benefit. Or it may be that such an expenditure as that for reducing a bad grade will permit heavier loads to be handled with the same or less effort. This is an indirect financial benefit. But in either case it is appreciable and justifies a certain investment toward its end. If the sum of all the direct and indirect benefits does not prove greater than the cost of the investment, then the borrowing of funds for the purpose is not justified. Therefore, when funds have been borrowed for road improvement, in order that their investment shall be profitable, it is necessary to expend them with discretion and in such a way and to such ends that waste, lost motion, or inefficiency and extravagance do not result. The cheapest possible results, compatible with economy, in the long run must be secured and the most results must be secured from the money that are practicable. Otherwise the situation will be like that of the man standing on miry ground and trying to extricate himself by pulling upwards on his boot straps. The imagination will finish the description better than can the speaker.

At the works of a leading steel manufacturer at Munich, interesting experiments have recently been carried out with a new process, the invention of a Swiss engineer, O. Widmar, of Zurich. According to this process, tool steel is produced from iron by chemical means without remelting. Experts of different nationalities were present at these experiments, and they report most favorably on the new process.

It has been reported in Calcutta that the Punjab Government has entered into an agreement with the Kashmir Iron Mines and Power Syndicate, Limited, providing for the erection at Dandot, of a factory for Portland and other cements, limes and plasters. In addition to the concession, the agreement confers a double 10-year monopoly on the company in regard to the manufacture and supply of cement, etc., in the Punjab. During this period no other Government land in the Punjab is to be allotted or leased, nor any other concession granted for the purpose of manufacturing Portland cement. During this period the Government are also bound to purchase from the company all the Portland cement, etc., which is required for works carried on by them, such as works for municipalities and local bodies. On the strength of the above it is promised to form a public company, to be called the Punjab Cement Company, to be floated privately.

PRACTICAL DESIGN OF STEEL STRUCTURES.

THE following notes formed part of a paper read before the Cleveland Engineering Society by Mr. Jos. R. Poe, President of the Poe Engineering Company, of Cleveland, O. Mr. Poe laid great stress upon the importance to the designer of practice and experience, in the fabrication and erection of structures. Dividing the practical design into: (1) Laying out and detailing in the office; (2) Fabrication in the shop, and (3) Erection in the field, the connection between the three were well explained:—

You may ask, what has the fabrication and erection to do with the design? It is just this: You must consider the cost of fabrication in the shop and the facilities for erection in the field. For instance: Pieces might be designed too long for erection with the derrick as constructed. An instance comes to mind where some bridge chords were designed to cover four panels; they were light and easily shipped, but the boom was too short, and, consequently, it became necessary to cut them in two. Permission had to be obtained from the engineering department, and also from the supervising engineer; then new splices designed, made and shipped, and holes drilled in the chords in the field. This caused considerable delay and loss, simply because the designer had not been practical.

Laying Out.—Upon the laying out and detailing in the office depend the success or failure of the subsequent operations. Even the profits of the company and the operation of the machine (if it be a machine) are dependent upon this first step of the practical design. After the contract is awarded and the stresses computed, the practical designer gets in his work. A theoretical designer will invariably pick out sections which are not common stock, and hence require special rolling. The professors in the technical colleges try to teach the students which are standard and which are special shapes, but most of them forget it until it is demonstrated in the hard school of experience.

The mills will not make a special rolling, when busy, until they have a large tonnage of that section. Now, if the common stock sections be used, they can be obtained from the stock pile at the mill, or if in a rush, can be secured from a jobber. If they be extra long or in large quantities an immediate rolling will be made. A few of the common sections might be mentioned here:—

Angles.

2½ x 2½ x ¼ and 5/16	3 x 2½ x ¼ and 5/16
3 x 3 x 5/16 and 3/8	3½ x 3 x 5/16 and 3/8
5 x 3 x 5/16 and 3/8	5 x 3½ x 5/16 and 3/8
6 x 3½ x 3/8 and 1/2	6 x 4 x 3/8 and 1/2
6 x 6 x 3/4 and 1	

Channels 6 in., 8 in., 10 in., 12 in. and 15 in. lightweight sections. Eye-beams same depths as channels, but including 20 in. and 24 in.

Plates are generally rolled to order. We are making a practice of ordering plates 48 in. x 10 ft. for details, when the plates are to be cut irregular. The shop then cuts them to the best advantage and what is saved is good stock. Ofttimes they use plates from the scrap pile and keep the 48-in. plates for stock. The designer should also watch his own stock and use from it whenever possible. Structural shops will often request permission to use some heavier section or other section equally as heavy as the design, simply because they have it in stock with very little call for it. Permission to use this section will expedite the contract and work to the advantage of both contractor and customer.

In laying out and ordering material, the main members should be ordered to the best advantage, avoiding extra cutting and waste in the shop. The details should be ordered liberally and should be capable of lending themselves to any changes that may be found necessary as the work of detailing progresses. After the work of laying out and ordering material comes the detailing, which is done by a corps of embryo engineers and practical draftsmen.

The detailing and checking are simply the making of pictures of each member, capable of being reproduced in the shop. Along with the detailing go many phases of the practical design. Members must be made the proper size and length to facilitate shipping and erecting in the field. Of course, this should be taken care of in the preliminary design, but the detailing is the final judgment. Every member should be checked for strength, shipping dimensions and erection, as well as mechanical errors. Every possible rivet should be driven in the shop, but none that will prevent the members from sliding into place quickly in the field. Often rivets have to be cut out in the field before members can be erected, which means the delaying of from six to ten men and a derrick or crane. This unnecessary delay would pay the expense of driving from ten to twenty field rivets.

A good example of driving rivets in the shop to facilitate erection is found in the columns of an office or mill building. All connections for beams and girders should be riveted to the columns, which reduces the shop work on the beams, most of which will not have to go to the riveter, and also expedites the erection. For instance, take a beam in an office building. The connection is riveted on the column, the beam is dropped into place and the connection forms a shelf that supports it until it is bolted.

While speaking of columns, let us digress a little and touch on the footings. No grouting should be allowed, because it is liable to disintegrate and leave the column resting on three points of support. The writer has seen columns where a two-foot rule could be pushed under them with very little trouble. One well-known railroad requires concrete to be poured one-half inch above grade and then dressed down to a smooth bearing, while others sometimes use sheets of lead under the column.

Steel should be designed to avoid the use of falsework wherever possible. Take, for example, cantilever and rolling lift bridges. A special traveller climbing up the back of a rolling lift bridge has become a familiar figure to all of us. This is a very good example of the absence of falsework and serves two purposes: first, it keeps down the erection cost; and second, it allows an open channel and free use of the old swing span.

In every steel structure each member should be designed, if possible, to be self-supporting, or capable of being guyed in place until the proper tie member is erected. Splice plates riveted in the trough of the channels are a hindrance to the easy erection of bridge chords. These plates necessitate the sliding of the chord in place, while the post and diagonal prevent this motion and require a straight drop. All structural members should be designed, where possible, to allow them to be dropped vertically in place. The weight of the member thus aids the erectors in catching the holes.

Proper clearances should be provided. Make the outside dimension of the entering member one-eighth of an inch less than the inside dimension of the entered member. The line of rivets next to the splice should be omitted.

All extra long members (and, in fact, any unusual construction) should be submitted to the superintendent of erection for approval. Failure to do this often catches the erectors unprepared and causes delay. It has necessitated the cutting of members in the field.

The æsthetic design should also be considered. All exposed members of a steel structure should not only figure strong enough, but should have the appearance of strength. The engineer will thus avoid criticism from the general public and the press. The writer remembers a certain important member in a steel structure that was made too small for its length. It figured strong enough, and it was made that way. Every engineer who looks at it remarks that it is too small, and it is needless to say that the designers have regretted its construction many times. However, it is still standing, although it has received some very hard knocks, one of which buckled it, yet it did not fail.

Structural steel frames for buildings are becoming very common, and have created a demand for a construction which is cheap, yet good. Engineers and contractors are studying all types of construction to find the one best suited to their needs.

An important item in the practical design is the number of rivets to be driven. There is a tendency among the better class of draftsmen to put in too many, when in doubt about a connection. On the other hand, another class of draftsmen will skimp every connection. Too many is poor business, and too few is bad design; neither should be tolerated.

To expedite the work in both office and shop, certain standards must be followed. One of the most important is the number of duplications. Beams should be made alike as far as possible; likewise the shelf angles supporting them. Now, if every different column changes, the beams or shelf angles must change. This requires more careful checking in the office and more pieces to lay out and store until ready for fitting up. The fitter must find the correct angles from many small piles instead of taking any angle from a certain large pile. This objection can and probably will be overcome as the call for these sections increases.

Another item is the ease with which the rivets can be driven. For instance, a column made up of two channels with their toes turned in and laced is a very hard column to rivet. It may be impossible to drive them with the machine, hence the rivets must be hand-driven. If they can be driven with the machine, it will be necessary to lift the machine up after driving three, at the most.

Laced members are expensive in the shop and should be avoided if possible. In fitting up, every bar must be bolted in place and the bolts removed one by one as the riveting progresses. With plate construction, only 15 to 20 per cent. of the holes are bolted, the others being open. The riveter runs down and fills them, then back again, filling the holes which were bolted. The bolts are removed by a helper, working behind him.

The mineral production of Peru for 1912 is contained in the Boletin del Cuerpo de Ingenieros de Minas de Peru, No. 80, 1914, as follows:

Peruvian Mineral Output, 1912.

Minerals	Weight unit	Weight
Coal	metric ton	278,027
Oil	metric ton	233,600
Gold	kilogram	1,435
Silver	kilogram	324,352
Copper	metric ton	26,070
Lead	metric ton	4,050
Vanadium ore	metric ton	3,048
Bismuth (fine)	kilogram	51,038
Tungsten ore	metric ton	105
Mercury	kilogram	400
Borax	metric ton	1,074
Salt	metric ton	23,202

SEWAGE DISPOSAL PROBLEM IN CHICAGO.

IN their preliminary report upon the sewage disposal problem of the City of Chicago, Dr. Geo. A. Soper, A. J. Martin and J. D. Watson, a board of experts, appointed by the harbor and river improvement committee, have cited the following to be the conditions found after a careful study of the sanitary problem of the city:

The conditions of sewage disposal which exist in the Chicago River and its outlet are conceded to be unsatisfactory, and it is the opinion of the board of experts that the disposal of the sewage cannot be made to answer the reasonable demands of sanitation without radical improvement.

It may be said that nuisances exist in various places in the contributing arms of the Chicago River, but not to a considerable extent, however, so far as the personal observations of the board of experts have extended, in the main channel from the lake to the drainage canal. Practically the entire watershed of the Chicago River is populated or soon will be built up. The drainage channel flows through open country for many miles, and its condition, although observed to be foul by those who have had occasion to visit it, does not constitute a nuisance for the reason that none are compelled to reside or work within the sphere of its offensiveness.

Vital statistics of Chicago have been compared with those of large cities whose drinking-water supplies have been filtered, and it appears to have been shown that Chicago has one of the cleanest and purest waters of any large city in America. There seems generally to have been sufficient protection afforded up to the present time. Apparently the object in placing the intakes as far out as practicable into the lake has been not only to avoid contamination along the water front but to get clear water. At times of storm the water of Lake Michigan becomes turbid near shore, clay being conspicuously present. After fresh easterly winds even the best water obtainable from the 4-mile crib becomes noticeably turbid.

On the days when the inspections of the Desplaines and Illinois Rivers were made the water was offensively polluted with sewage as far as Ottawa—85 miles from Lake Michigan. Where bridges crossed the stream it was possible to see unmistakable evidences of the sewage. Odors were noticeable, grease lay upon the surface of the river, dead fish were numerous and large quantities of sewage fungus were observable in the water. Through the whole course of the stream from Chicago to and below Ottawa gulls were seen feeding on the solid refuse which the sewage brought down.

The report contains the following opinions and recommendations:

Dilution alone cannot be relied on as a permanently satisfactory method of disposing of the sewage of the district. It offers an insufficient means of disposing of the sewage at the present time, and would prove still more inadequate in the future, in spite of the full quantity of water which the drainage channel can carry. It will ultimately be necessary to treat practically all sewage before it is discharged. The conditions which now exist are not so insanitary as to call for improvements which will involve immediate and large expenditures of money, but the preparation of comprehensive plans for sewage disposal, water supply and river development should be undertaken immediately.

It is not possible to procure a satisfactory water supply by diverting the sewage to the drainage channel and extending or altering the location of the intakes. For the protection and improvement of the supply the city should look forward to the construction of filtration works.

Some of the principles and lines on which to proceed are:

The principle of diverting the sewage from the lake should be adhered to, in spite of any degree of sewage purification or water purification which may be employed.

Full advantage should be taken of as large a volume of diluting water as may be obtainable from the lake, in order that the cost of finally disposing of the sewage may be reduced to a minimum.

It is desirable to concentrate as much of the sewage as practicable at a point beyond the built-up sections of the city and in the vicinity of the drainage channel, where the sewage can be treated sufficiently to permit the effluent to be discharged without serious danger of offense.

To avoid excessive cost and in order to relieve the drainage channel as far as practicable, it will be desirable to treat the sewage of some parts of the city in the areas in which the sewage is produced.

Practically no sewage should be discharged into the Chicago River or the drainage channel without some form of treatment, except in times of storm, when suitably located overflows will be permissible. The sewage should, for the most part, be collected by a system of intercepting sewers running along the waterfront and extending to the central disposal station.

The minimum requirement in the treatment of the sewage at the main station should be the removal of the suspended solids by screens and settling basins.

The arms of the Chicago River which have no present or future value for navigation, and which are now in a foul and stagnant condition, should be filled in.

All considerable flows of especially foul liquids, such as those from the stock yards, should receive special treatment before they are discharged into the Chicago River or the drainage channel.

The disposal of the sewage in the Calumet territory is a local problem which can and should be solved by the construction of one or more purification plants.

SEWER DISCHARGE DIAGRAM.

Last year a sewer discharge diagram prepared by J. M. M. Greig of the Sewer Department, Toronto, was published in *The Canadian Engineer*. Some reprints were made, a few of which are still to be had. The diagrams, together with the accompanying text, are each mounted on a stiff board. One of these will be sent to any reader whose request reaches us before the supply is exhausted.

A statement recently given out by Toronto authorities, announced that with the advent of spring, \$83,000,000 worth of engineering work alone would be well under way in Toronto. The Federal, Provincial and Municipal Governments, with the railways and private corporations, will spend on the development of Toronto well over \$250,000,000 during the next few years. How conservative this estimate is will appear from the following table compiled by Mr. G. H. Maitland: Harbor Board, \$24,000,000; water front viaduct and new Union Depot, \$15,500,000; additional filtration plant at Island, \$1,300,000; Bloor-Danforth viaduct, \$2,500,000; east city waterworks plant, \$6,700,000; new buildings (exclusive of those mentioned in this list) averaging at \$30,000,000 per annum for six years, \$180,000,000. The foregoing six items alone total \$230,000,000. The list does not take into account street extensions and widenings, pavements, the North Toronto depot, civic car-line extension, general maintenance, sewers—three of which sewer systems will alone cost \$7,000,-000 [illegible] no less than \$106,500,000, an increase of over 166 per cent. in four years.

HIGHWAY LEGISLATION.*

By W. A. McLean,
Provincial Commissioner of Highways for Ontario.

HIGHWAY legislation is, at the present time, prominently before the public in every province of Canada, in all of the United States, and in almost every civilized country of the world. Three-quarters of a century ago, there was much activity in the building of main roads. Had that activity continued, the older provinces of Canada would have been well equipped with roads, and the present emergency would not have existed. A long period of neglect, and the greater efficiency of the road by means of the motor car and motor truck, have united to create an urgent need for road improvement.

Legislation alone will not build roads. Laws are merely the rules of the game. They define the game and provide for fair play. But good laws are necessary to the building of roads; as necessary as is the steam engine to the moving of a train; or as essential as the dynamo to the creating of electric current. While they do not make roads, they are the machinery for assembling and directing the power that already exists. They are the means by which energy is focussed and applied. The real source of energy, the real motive power in the building of roads, is in the ideals and demands of the people.

No two countries in the world have similar road laws. However satisfactory a code may have been in one country, it would be impossible to impose it with equal success, indeed without disaster, upon another. Climate, past traditions, customs, temperament and viewpoint of the people, existing municipal and other organization, local requirements and conditions affecting traffic, must be considered, and the adjustment of correspondent legislation is a matter for delicate and skilful treatment.

While the system of one country could not be adopted by another, all experience is of value in considering the requirements of any set of conditions, and may teach us what to imitate, to modify, or to avoid. A study of measures successful in other countries will indicate, furthermore, that there are certain principles which are universally applicable and necessary to success.

Cities and Main Roads.—That cities should contribute to the cost of roads in the open country is one of the first principles which Canadians need to learn, and embody in their legislation. Prior to the initiation of railway construction, central governments, with revenues drawn from, or to be credited to cities as well as rural districts, were active in road construction, particularly main highways. These main roads were heavily travelled by long lines of wagons carrying farm produce, and stage coaches for travellers, with taverns for their entertainment at every cross-road.

In the progressive European countries their roads were built more than half a century ago, and have since been well maintained. On this continent the building of main roads was little more than commenced with the coming of the steam railway; towns and cities concluded that their interest in the common road had ceased and their financial support was withdrawn. With the ceasing of long-distance travel and transportation, toll-roads were no longer profitable for private corporations. The resident of the city for many years did not even realize the value of good pavements in front of his own home, and he said to the farmer: "The country roads are yours. They are of no concern to me. If you want to drive axle-deep in mud, do so. If yon want to fix them up, pay for them yourself."

With the coming of the bicycle and the pneumatic tire a quarter of a century ago, there was the dawn of an awakening. That has been enlarged upon by the motor vehicle. To-day the economic value of good roads not merely to the producer, but to the consumer; not merely to the farmer, but to the merchant and manufacturer, is being studied; and that every community is benefited by good country roads is again becoming a generally accepted truth. Initiated by the personal use of bicyclist and motorist, it has gathered impetus from the high cost of living, leading to the broader knowledge that the city and town are immensely benefited by the progress and development of the township. Cities are realizing that the cost of good roads is their own burden, as well as that of the farmer.

The matter is of deeper interest in Canada than in the United States, from the fact that the revenues of State Governments are drawn largely from direct taxation collected with the municipal rates, whereas in Canada, provincial revenues are derived from indirect sources, not readily expanded to meet growing needs, and direct taxation for provincial purposes is avoided. As the contribution of cities to main road construction is necessarily made through the wider authority of provincial administration, the matter is creative of difficulty.

Municipal Authority.—Local self-government through municipal organization is in the highest degree desirable in nurturing an intelligent, progressive, self-reliant people. A lively interest in their local affairs—of roads, drainage, education—creates a sense of responsibility and a knowledge of government that shows itself in the home-life and in the higher statesmanship of a people. It is my personal observation under many conditions, that the fullest responsibility for local self-government meets a ready response from all the best citizenship, and has its reward in the greater dignity of the individual and of the nation.

A central government of province or nation, therefore, should not do for the people what they can do for themselves. A central government has enough to do with its revenues in ways that local self-government cannot, without diffusing its energies upon matters which private enterprise or local organization should control.

It follows that the central administration should, within bounds of equity and magnitude, allot to municipal bodies the necessary authority to control matters within municipal scope, rather than to retain or absorb them. By giving to local authorities the means of organization, they can do much in the way of raising money, and directing the expenditure toward effective road maintenance and betterment. It is primarily the business of a central government to see that local authorities are provided with the most efficient means of organization possible, for road purposes.

Centralized Authority.—On the other hand, experience in our own and other countries has indicated that a complete system of good roads cannot be created by local organization alone. In Eastern Canada the main roads to which we have referred (though they have suffered by a long period of neglect) were opened and improved by the central governments, or were constructed by toll road companies. The same was true in the Eastern States, and in the revival of road-building there, roads are being built, or are being largely subsidized by State Governments. In the United Kingdom of Great Britain and Ireland, the existing main roads were constructed by

*Read at the First Canadian and International Good Roads Congress, Montreal, May 18th, 1914.

turnpike trusts; they later passed to counties with an Imperial subsidy for maintenance, but national influence is now being restored. In France the great system of national highways was built, and is maintained by the State; while through subsidies, the influence of the Department de Ponts et Chausseès, is extended to the Departmental and Communal roads. In Germany the roads were built as military highways by the central government.

The maintenance of main roads, as with construction, has received and is receiving the support of the central governments. In the older countries of England, France, Italy and Germany, the main roads have long since been built, and the present large expenditures of central authorities is almost entirely for maintenance; and it is for road maintenance that their finely organized engineering corps are retained. Central governments should exercise a controlling hand in the maintenance of main roads, which they have built or largely subsidized.

Road Classification.—It has been pointed out that, while municipal responsibility should be encouraged, there is a point at which, in order to obtain results, the influence of a central authority must bear directly upon road administration. A consideration of the "Classification of Roads" will assist in determining the point at which the forces of a central administration should be applied.

Roads should be built to meet the needs of traffic. For example, there are roads which, lightly travelled, by an initial expenditure of $1,000 a mile, will remain in good condition for ten years; on the other hand, there are other roads which, because of heavy traffic, demand an outlay of $1,000 per mile annually for maintenance alone. For this reason, roads admit of classification according to traffic for purposes of construction and maintenance, revenue and administration. They must be constructed and maintained adequately; revenue must, in equity, be derived from those who are benefited; and organization must be commensurate with the work.

Commonly, there are four phases to be considered with other possible subdivisions attendant upon local circumstances. These are:—

1. Interurban roads, between large cities; in general they are the main roads of a century ago, which were paralleled by steam railways.

2. Main market roads radiating from market towns and shipping points, usually at right angles to the interurban roads.

3. Local roads, or outlying feeders to the market road, but which serve only a limited area, and upon which traffic does not concentrate.

4. "Suburban roads"—the main roads adjacent to large cities, which carry an intensified form of market and other traffic, and which may be part of an interurban route. These roads usually carry the heaviest traffic of the country.

Division of Labor.—Again, gathering previous threads, we have reached the conclusion that local responsibility for roads is desirable as far as possible; that cities should contribute to the cost of roads; that the control of main roads or a directive influence upon them by central authorities, is an established principle in the creating of a complete system of good roads. With local authorities in charge of local roads, those of least cost and traffic, and central governments at the other end controlling or directing the more costly "interurban" roads it becomes a matter for special consideration in every province and country as to the intermediate point at which the "division of labor" should be made. It is too extended a matter to consider, in a short address, what has been done in the various countries in this regard, but it is perhaps of timely interest to observe the recent proposals for the Province of Ontario. These suggestions were:—

1. That township councils should provide for and control the roads of local travel, with the proviso that as a means of encouraging better methods and organization the province will grant a subsidy of 20 per cent. of their cash expenditure, for a limited period of years.

2. That county councils should provide for and control the main market roads, the province to grant a subsidy of 40 per cent. of their expenditure in construction and maintenance, the work to be under provincial regulations.

3. That all cities having a population of 10,000 or over should levy a tax of 3/4 of a mill annually on their assessment to be spent on the main market roads of a suburban area surrounding each city.

4. That the province, from the revenue derived from motor vehicles, should take the place of the cities in interurban roads (outside of suburban areas) and pay two-thirds of the cost of construction; thereafter, 40 per cent. of the cost of maintenance.

For the control of expenditure on suburban and interurban roads, it is proposed that boards of trustees be appointed, their work to be carried out under regulations and supervision of the Provincial Highway Department.

Supervision of Roads.—Clearly defined responsibility; skilled and experienced supervision of roads by municipality and government, each in its own sphere, are allied objects, which should be at all times kept in view in forming legislation. Old laws cannot be uprooted, and fully developed new laws put in their place over night. Skilled road engineers and overseers cannot be created in a day by Act of Parliament. But Acts of Parliament can, progressively, as public opinion permits, lead to the stage at which every municipality will be required to place its road construction and maintenance under the supervision of men who will be kept in office permanently so that they may acquire the skill and experience so much needed.

One of the difficulties of the day in Canada is that, in commencing and carrying on our work, we are too often compelled to put it in charge of men who are inexperienced, and who have to gain their knowledge and experience through a course of costly mistakes at the expense of the public. Schools and colleges cannot do all in turning out the class of men needed. They can do something to initiate the process of education. But the public must learn patience in a situation which only time can remedy. The matter is one which suitable legislation could greatly foster by requiring each municipality to appoint a road superintendent as permanently in office as a municipal clerk or treasurer. The countries of Europe largely owe their superior roads to the fact that, to the laborer, the repairing of roads is a permanent trade, and to the foreman and superintendent, it is a life-long occupation.

The Frontage Tax.—The frontage or area tax is from time to time suggested, and is to some extent used to provide for road construction in the open country. Care should, however, be taken in applying it to farm property. There can be no doubt that land values are advanced by the building of good roads; and that to increase the assessment on these lands causes the owner to pay only on the new values without requiring him to pay anything on capital account.

If we wish to encourage road construction, is it advisable, by levying a frontage rate, to collect the cost of the work, and at the same time place, on an increased assessment, a tax for all local purposes? It is subject to the old objection that land should be taxed for its intrinsic

value, not for the improvements on it. It is reasonable to conclude that, if the owner pays for the construction of a road past his farm, he should not be penalized by an increased assessment because of it; but, on the other hand, if the frontage tax is not applied, the natural course of an increased assessment should follow. In special cases, if a road of exceptional quality and cost is built, the owners may not feel it a hardship to pay a portion of the cost by a frontage or area levy, as well as their tax on an increased assessment.

In coming to that conclusion, we have considered farm property only. The owner wishes the road past his farm because he wants to live on it. He does not wish to sell. Apart from improved market facilities, the farm is no more fertile or productive. That is the general rural condition.

But adjacent to large centres of population, good roads have another effect. Lands reached by them are often changed in character. From purely farm purposes, they may, very often do, obtain a new value for residential lots, factory sites, or market garden plots. When an expensively built road gives lands a new commercial value beyond that of farm property, permitting the owner to sell for fancy prices at a large profit, the payment of a local improvement tax on a frontage or area basis, is just and entirely practicable in application.

Motor Vehicle Fees.—An emergency exists to-day in the road situation in every country, particularly on this continent. If we need good roads to-day the work should have been commenced fifteen years ago. If we will need a system of good roads fifteen years hence, we should begin construction now. To carry on the work, governments urgently require increased revenues for a large outlay is necessary. Everywhere the motor vehicle, for which the best roads are now being urged, is recognized as a proper object of taxation. They are commonly owned by men of means, they do serious injury to the roads, and their value to the owner is largely increased by the extension of good roads, so that he can travel over a greater area with more speed and comfort, and with reduced wear to the vehicle.

To meet the present emergency, the opinion is advanced that every owner of a motor vehicle should be willing to contribute a reasonable annual fee. As to whether the taxation of motor vehicles should continue for all time, there may be room for doubt. There is every probability that the number of motor vehicles will increase largely, and that they will become the most common user of the roads. When that stage arrives, while the imposition of a tax may be justified on a "personal property" basis, it can scarcely be continued as a penalty for injury to the road, and on that score should become as obsolete as the toll road.

General Highway Legislation.—Highway legislation of a varied kind is, in all countries, steadily increasing in volume. With laws, as with trees, there is need for constantly pruning old and dead wood, in order that the new growth may be encouraged and provided for. Unfortunately, some of the dead wood, such as statute labor, is difficult to remove, and remains a hindrance to more efficient measures. Necessary highway laws, of all countries, are largely typified by those of Ontario; the more important of which are:—

1. The highway sections of the Municipal Act, defining the powers and duties of municipal councils relating to highways.
2. The Local Improvement Act, providing for what is commonly known as the frontage system.
3. The Act respecting statute labor.
4. The Highway Improvement Act, making provision for provincial subsidies to main roads.
5. The Colonization Road Act, providing for roads in the northern and sparsely settled portions of the province.
6. The Highway Travel Act, enumerating what may be termed the "Rules of the Road."
7. The Motor Vehicles Act, containing provisions governing the use of motors on the highway.
8. Miscellaneous Acts relating to snow roads, toll roads, toll exemptions, snow fences, traction engines and tree planting.

While there are many phases and details of highway legislation, the immediate need is to make adequate arrangement for construction and subsequent maintenance. Laws toward this end should be just as regards taxation; the division of responsibility should be well considered; there should be ample provision for skilled and experienced control; methods of organization should be simple in their application. With fair play assured, the citizens of Canada may be depended upon to enter into earnest cooperation.

NEED OF ROAD CONSTRUCTION AND MACHINERY IN DOMINICA.

It is stated that Dominica is likely to undertake soon an extensive scheme of road construction, and that an opportunity for business for manufacturers of road machinery is consequently afforded. At present the island has not a single good road and many sections of it are entirely without transportation facilities. Owing to the extensive cultivation of limes and the high prices obtained for them the owners of some of the large estates are becoming wealthy and even the peasant proprietors are very prosperous, but many of the estates are very badly in need of roads to carry their products to market.

The British Secretary of State is strongly urging the adoption of a comprehensive scheme of road construction, and the general sentiment of the taxpayers in the island being strongly in favor of such a programme it is almost certain to be undertaken in the near future. At present all road work is done by hand and even for the improvement and maintenance of roads already established it would be economical to use road-making machinery. As an illustration of the need of roads in some sections of the island, it is stated that in one district where at least $300,000 have been expended during the last 12 years in the development of lime estates, most of which are just coming into bearing, the cost of transporting fruit and lime juice is so prohibitory that it may be necessary to allow limes to rot on the ground although at present prices they would make fortunes for the estate owners if they could be got to market. It is stated that in this district the cost of carrying a cask of lime juice to Roseau, the shipping point, is from nineteen shillings to twenty-one shillings.

Canadian manufacturers of road machinery who think of supplying the requirements of Dominica should note that it is a land of hills and valleys, that most of the hillsides are fertile and suitable for cultivation or for growing limes, cocoa, coffee and oranges at quite high elevations and that it will consequently be necessary to construct roads on hillsides as well as in the valleys. The general opinion seems to be that the roads should have easy grades and be suitable for motor cars. At present most of the roads are only bridle paths and not very good bridle paths although they are used by horses, mules and donkeys.

The firm of Messrs. Wettlaufer Brothers of Toronto, have opened a branch of their general engineering and manufacturing business at [illegible] Dewdney Avenue, Regina, Sask.

The Canada West Grain Company of Melfort, Sask., has opened an office at Winnipeg, Man. It is the intention of the company to build several new elevators this summer and to purchase several others.

Editorials

INDEXING TECHNICAL ARTICLES.

Beginning with this issue, *The Canadian Engineer* will endeavor to provide weekly a convenient and adequate means whereby its readers may establish for themselves a card index of the articles of special interest to them in their work. Little originality is claimed for the new departure as it has been tried in one way or another by several other prominent engineering journals, with a fair amount of success. Obviously readers have frequent occasion to refer to articles that have previously appeared in these columns, and unless such opportunities are taken advantage of in the investigation of a problem at hand, a full measure of benefit is not being derived from the store of information there available.

The page immediately inside the front cover of each issue has been reserved for this purpose. On this page will appear an index and synoptical reference to the more important articles which that issue contains. It will convey at a glance an idea of the scope of each article, its approximate length, its title, its outstanding features and the page upon which it begins. This information will be arranged concisely and in such a way that an engineer may select those articles that may be of general or particular interest to him in his work, and mount them individually on ordinary blank cards. It only remains to file each succeeding set, as issue after issue comes to hand, each reference under its proper heading, such as bridges, sewage disposal, road construction, etc. Then, when a future occasion arises, in which he desires to look up articles on a special subject, he has only to refer to his card index system, which will at once place him in possession of a list of all the articles that have appeared during the period of time over which his index extends. He may see at a glance what each one covers and the page upon which each is to be found.

Undoubtedly the system will prove a time saver in any office or library and will enhance the value to the reader of the journal itself in providing a readily referred-to index covering what has been published since the last semi-annual index was issued, and in classifying articles to suit the needs of each and every reader.

PROGRESS OF THE CITY-PLANNING MOVEMENT.

The 6th National Conference on City Planning, held in Toronto May 25th, 26th and 27th, was a clear indication that the movement toward an intelligent and scientific treatment of the growth of our towns and cities has many evidences of encouraging progress. That the Conference was attended by delegates from 74 cities and towns and had associated with it exhibits from no less than 31 Canadian cities and towns, indicates also that it is being recognized in an approving way. Fortunately, the ideas entertained for some time by the public in general and, in the earlier stages of the movement, by some of its most consistent advocates, viz., that city-planning would deal with the general physical transformation of cities, particularly the congested central and business portions, is becoming overcome. People are realizing more and more that the city-planning movement has to deal primarily with the growth of a community, with only such changes in the old established sections as are necessary for the health and convenience of its populace.

The addresses and papers presented at the Toronto Convention clearly emphasized the degree of reformation which might be expected to follow an application of modern science and knowledge in the expansion of our cities. The need of such application is always with us. The knowledge itself is not new, as a general rule, but the various city officials possessing it, when organized into co-operative bodies, are able to confine their ideas and to impress the citizens, particularly those who have to do with the growth of the city, with the logical importance of planning in advance of that growth. Those of our Canadian cities which have already adopted the idea in an official way are making encouraging progress, while others are beginning to show signs of activity.

The draft of a city planning act which was prepared by a committee on town-planning and housing legislation appointed by the Commission of Conservation, Canada, and which was presented for discussion during the Conference, incited a widerspread interest throughout the country than that which would have naturally resulted from the meeting. This art deals with the establishment of a town-planning board in each of the various provinces. In addition each municipality may create for itself its own housing and town-planning board, or the central board may authorize the establishment of such a local board to prepare a town-planning scheme under the direction of the former. The act covers a number of questions contingent upon the movement, such as taxation, compensation, etc. It came in for a considerable amount of discussion at the Convention, and many suggestions were brought up in connection with it.

Undoubtedly one effect of the Conference and its proceedings will be an agitation throughout the various cities of the Dominion for a measure and an organization which will have for its aim a more intelligent and comprehensive direction of the growth of the cities and their various departments than has been known heretofore.

ROAD CONSTRUCTION IN NORTHERN ONTARIO.

From the report of Mr. J. F. Whitson, road commissioner, it is ascertained that 764 miles of roads were constructed, or partly constructed, and improved in Northern Ontario during the season of 1913. Of the total mileage 500 miles were graded, part of the macadam road being macadamized or resurfaced. About 280 miles of the total were cut through forest.

During the season of 1912 a good deal of work had consisted in cutting out new roads which, owing to the wet season, it was found impossible to burn off. Last year all these roads were burned off and many of them graded and ditched.

In the older sections the trunk roads, which often followed the ridges, and which were in many instances crooked and unsatisfactory as to grades and drainage, were straightened out, grades modified, and special attention given to drainage, old culverts being replaced by permanent ones of stone, corrugated iron pipe, etc.

The sum of $1,081,172.28 was expended during 1913 on the construction of roads in the northern section of the province, thus making a total expenditure at the end of 1913 of $1,274,255.08 out of the $5,000,000 loaned for this purpose.

WASH BORING FOR THE WINNIPEG-SHOAL LAKE AQUEDUCT

OPERATIONS DURING SEVERE WINTER WEATHER AT INTAKE SITE AND FALCON RIVER CROSSING—DATA CONCERNING COSTS OF EQUIPMENT AND OPERATION—METHOD OF SINKING THE TEST HOLES.

DOUGLAS L. McLEAN
Of the Greater Winnipeg Water District's Field Staff.

IN connection with the extensive field investigations undertaken by the Greater Winnipeg Water District and pushed forward under the direction of W. G. Chace, chief engineer, from November, 1913, to March, 1914, for the location of the aqueduct line and appurtenant works from an intake site at Shoal Lake to the City of Winnipeg,* considerable subsurface boring and test pit work was carried out. At Indian Bay, Shoal Lake, Party No. 3, of which the writer had charge, made a number of wash borings at the intake site and Falcon River crossing. Mr. R. T. Sailman, B.Sc., who had considerable experience on deep drill work in New York State, was detailed from head office to assist on this work, as well as to look after the entire underground explorations along the line to Winnipeg.

Fig. 1.—General View of Outfit. Fig. 2.—"Drilling." Fig. 4.—Jacks, used only to raise casing after drive weight has been in operation.

The work at Indian Bay was carried on under the severe climatic conditions of a Canadian winter, with a "string of tools" which, though complete for the purpose, was not as elaborate as that necessary for deep drilling. The following list of equipment with cost of same may be useful for reference when similar work in contemplated:

*Described in *The Canadian Engineer*, Vol. 25, pp. 605-[illegible] [illegible]rd, 1913).

TABLE I.—LIST AND COST OF EQUIPMENT.

Quantity.	Description.	Unit Price. $ c.	Cost.† $ c.
50 feet	2½" Extra heavy pipe (drive casing) in 5'-0" lengths, at....	.57	28.50
	Cutting and threading pipe...	....	5.00
50 feet ...	1¼" Extra heavy pipe—five 4'-0" lengths and six 5'-0" lengths, at	.25	12.50
	Cutting and threading pipe...	...	3.30
10 only....	2½" couplings, at	.16	1.60
11 only....	1¼" couplings, at	.08	.88
1 only ...	Malleable 1¼" tee, at	.16	.16
1 only.	Double run 10" wooden block, at	1.85	1.85
60 feet	¾" Manilla rope, at	.14 lb.	1.40

†At Ingolf Station, Ont.

Quantity.	Description.	Unit Price. $ c.	Cost.† $ c.
1 only	Hand force pump No. R. 470—30 gallons per minute, at	7.00	7.00
2 only	24" Stillson wrenches at	2.25	4.50
15 feet	1½" discharge hose at	[illegible]	4.50
20 feet	2" suction hose at	.35	7.00
1 only	1¼" street elbow at	.15	.15
1 only	1½" coupling for hose at	.30	.30
1 only	2" x 1½" bushing at	.10	.10
1 only	1½" short nipple at	.10	.10
1 only	1½" x 2" nipple at	.10	.10
1 only	Drive weight 7" diameter x 15" long, 2" hole all the way through long dimension, widened to 3½" from 4" below top to top, 1" hole through same 2" from top, for 3' of ¼" flexible wire rope for handle at	5.60	5.60
2 only	1½" chopping bits of drill steel with 1¼" threads 8" long at	6.00	12.00
6 only	Pairs lumberman's rubbers, 2 buckles, sizes 10, 11 and 12, at	1.60	9.60
1 only	Pipe vise to take 2½" to 1¼" pipe at	2.00	2.00
1 only	2" foot valve at	.45	.45
1 only	Machinist's hammer at	1.10	1.10
2 only	Cold chisels at	.35	.70
1 pair	Jacks 2½" x 18" with handles at	6.80	13.60
	Steel spindles for same at	.10 per lb.	1.20
2 only	Sleeve couplings, 1¼ W. T. at	.10	.20
3 only	Sleeve couplings, 2½ W. T. at	.16	.48
2 only	1¼" nipples 6" long at	.06	.12
2 only	1½" to 1¼" reducing couplings at	.10	.20
2 only	1½" nipples 6" long at	.08	.16
6 only	One-gallon pails at	.21	1.26
1 pint	Machine oil, black, at	.15	.15
1 only	2" nipple, 6" long, at	.10	.10
1 only	Recovering tap at	3.75	3.75
2 only	Sister hooks at	2.50	5.00
1 only	Clasps for 2½" pipe at	2.00	2.00
1 only	Hoisting plug at	1.75	1.75
6 only	Couplings for 1¼" pipe (extra) at	[illegible]	[illegible]
1 only	Ice chisel at	3.50	3.50
2 only	Axes, No. 3½, at	1.25	2.50
1 only	Air-tight heater at	2.10	2.10
1 only	Length stove pipe at	.10	.10
2 only	Chain tongs, No. 33 Vulcan, at	4.50	9.00
2 pairs	Extra leathers (front and back) for piston of Meyers low-down force pump at	.35	1.40
3 only	Logs for tripod. Delivery of outfit from C.P.R. station to site (18 miles), at		12.10
			$171.54

With this equipment, a general view of which is shown in Fig. 1, the process of sinking the test holes was very simple. It was substantially as follows:

The derrick or tripod, equipped with three logs, was set up over the station, where a hole was cut through the ice and the depth of water obtained by sounding. After this, a suitable length of casing was put down. At the same time a hole for the pump suction was made and a fire started in the water heater, in order to facilitate the thawing of the tools. Then the drill rod of required length, with chopping bit on lower end, and hoisting water-swivel on upper end connected to derrick-rope and by hose to the force-pump, was put down inside the casing. The position of the bottom of the casing and the drill rods having been noted, the drill rods were churned up and down by means of rope over a block attached to the tripod. At the same time, water was forced down the centre of these rods to an outlet in the chopping-bit, and thence up between the rods and the casing (see Fig. 2). The chopped material brought up by the water jet was noted by the leader in charge of the work.

To sink the casing, chain tongs were attached, and it was rotated, as shown in Fig. 3. This rotation or turning of the casing to keep it free from sticking to the material drilled through, was the detail that added most to the speed of work, not only in sinking the casing, but more especially in the pulling of the pipe.

This method of sinking the casing was not practical at all times and in some cases the drive weight was used to pound the casing down. After it had been used, it was necessary to use the two jacks to draw the pipe, as shown in Fig. 1. As the hole was sunk either by rotation of

Fig. 3.—Showing Method of Rotating and Sinking the Casing.

casing, or driving, constant watch was kept of the position of the bottom of the casing and the drill rods, together with careful note of the materials brought up by the water jet. For this particular piece of work at Indian Bay, it was found advantageous to use a force of one leader, or foreman, and four laborers.

The progress that can be made under winter conditions, and the cost of same, is given in Table No. 2. This gives the footage, the materials encountered, the temperatures and the labor and food costs. It should be of use for information when similar work is contemplated.

(For Table 2 See Next Page.)

MINERAL PRODUCTION IN GREAT BRITAIN.

As shown by a condensed statement issued by the Mine Inspection Bureau, the coal produced in Great Britain for the calendar year was 260,398,578 long tons in 1912, and 287,411,869 tons in 1913; an increase of 27,013,291 tons, or 10.4 per cent. The production of other minerals from mines included under the Coal Mines Act was as follows, in long tons:—

	1912.	1913
Iron ore	6,744,258	7,709,624
Iron pyrites	[illegible]	[illegible]
Clay and shale	[illegible]	[illegible]
Fireclay	2,287,719	2,585,763
Igneous rocks	268	688
Limestone	12,009	7,525
Sandstone and ganister	152,156	144,923
Oil shale	[illegible]	[illegible]
Barium compounds	[illegible]	[illegible]

The production of coal given above is practically complete, only a few thousand tons being obtained from open-pit workings classed under the Quarries Act. The output of iron ore will be increased considerably by the reports from metalliferous mines and quarries.

The number of persons employed in these mines in 1913 was: underground, 909,834; on surface, 218,056; total, 1,127,890, an increase of [illegible] over 1912.

WASH BORING COST DATA

Date	Depth of Water ft.	Depth of Muck ft.	Depth of Clay ft.	Depth of Sand ft.	Depth of Gravel ft.	Depth of Material Bored ft.	Total Length of Casing (includes Ice, Water and Materials) ft.	Force	Labor and Food Cost	Cost per Foot below Lake Bottom	Total Cost per Foot of Casing in Ice, Water, Material	Remarks	Ice Thickness on Ice Measuring Space ft.	Temperature 7 a.m.	Temperature 12 a.m.	Temperature 7 p.m.
1913.																
Dec. 24	13.0		[illegible]			[illegible]	43.0	Mr. Sailman at $[illegible]; 1 Topographer at [illegible]; 4 Laborers at [illegible]	$2[illegible]	$0.70	$0.465	Note—Wages include cost per day of board at 35 cents per meal	1.10	+[illegible]°	+[illegible]	[illegible]
1914.																
Jan. 9	...	..	..	..	....		....	1 Topographer, 2 Laborers	9.05	...	.....	Pulling casing pipe left since Dec. 24th	1.40	+4	+6	+[illegible]
10	12.5	..	9.5	9.0	2.5	21.0	34.1	1 Topographer, 4 Laborers	14.15	0.655	0.415		1.52	7	+5	+10
12	5.2	.	7.2	2.8	.	10.0	15.2	" "	14.15	1.415	0.951		1.70	21	+4	6
13	7.0	..	13.5	5.0	..	18.5	25.5	" "	14.15	0.765	0.555		1.75	+4	+16	+1[illegible]
14	14.0	.	4.0	11.0	...	15.0	29.0	" "	14.15	0.943	0.47[illegible]		1.78	+14	+35	+2[illegible]
15	9.7	..	13.5	5.8	0.5	19.8	29.5	" "	14.15	0.715	0.480		1.79	+18	+26	+22
16	7.1	..	8.5	...	7.4	15.9	23.0	" "	14.15	0.892	0.615		1.80	+19	+22	+1[illegible]
17	22.1	4.[illegible]	9.0	7.0	...	20.3	42.4	Mr. Sailman, 1 Topographer, 3 Laborers	18.40	0.966	0.434		1.82	+17	+22	+2[illegible]
19	37.[illegible]	..	23.7	24.7	15.2	63.6	100.6	Mr. Sailman, 1 Topographer, 3 Laborers	18.40	0.289	0.183		1.84	+34	+35	+3[illegible]
20	16.[illegible]	..	29.3	7.8	6.1	43.2	59.2	Topographer, 3 Laborers	14.24	0.330	0.241	Mr. Sailman ½ day, 1 laborer 3 hours on other work	1.88	+8	+10°	+3°
21	11.[illegible]	7.1	41.7	...	..	48.8	60.0	Mr. Sailman, 1 Topographer, 3 Laborers	13.70	0.281	0.228	For ½ day	1.93	−16°	−1	−6
22	14.5	1.0	8.5	...	...	9.5	24.0	Mr. Sailman, 1 Topographer, 3 Laborers, Man and Team at $6.05	21.40	2.250	0.892	Outfit moved from Consulting Engineers' intake site to island. Broke pump in afternoon. ½ day for team.	1.97	−21°	+8°	+5°
26	19.7	2.0	46.8	...	...	48.8	68.5	Mr. Sailman, 1 Topographer, 4 Laborers	20.95	0.429	0.305		2.09	+10°	+4°	−2
27	22.9	1.5	22.2	..	...	23.7	46.6	Mr. Sailman, 1 Topographer, 3 Laborers	9.20	0.388	0.197	½ day cleaning ice	2.14	−12°	+8°	+8
28	53.5	2.0	31.3	...	...	33.3	86.8	Topographer and 3 Laborers	15.00	0.450	0.173	Mr. Sailman ½ day work.	2.16	+4°	+22°	+24°
29	9.5	...	21.5	...	...	21.5	31.0	Mr. Sailman, 1 Topographer, 3 Laborers	9.20	0.428	0.297	½ day cleaning ice	2.19	−11°	−10°	−12°
30	19.4	0.7	31.2	..	...	31.9	51.3	Mr. Sailman, 1 Topographer, 3 Laborers	18.40	0.578	0.359		2.21	−24°	−8°	+6°
31	19.3	1.5	10.4	...	...	11.9	31.2	Mr. Sailman, 1 Foreman at $2.80, 3 Laborers	10.30	0.866	0.331	Shut down for repairs in afternoon	2.26	+2°	+4	5
1914. Feb. [illegible]	19.4	1.0	54.0	..	..	55.0	74.4	Mr. Sailman, 1 Foreman at $2.80, 3 Laborers	19.82	0.360	0.266		2.41	[illegible]	+7	1
4	10.1	...	38.6	...	...	38.6	48.7	Foreman, 4 Laborers	13.00	0.337	0.262		2.48	−8°	+1°	10
5	20.[illegible]	2.0	29.3	.	..	31.3	51.3	"	7.80	0.249	0.152	Chg. to clearing ice $5.20.	2.52	−32°	−9°	−15
6	37.[illegible]	[illegible].5	20.9	..	...	24.4	61.4	"	13.00	0.533	0.212		2.53	−36°	−7°	−18
7	45.2	...	22.3	...	...	22.3	67.5	"	13.00	0.583	0.193		2.57	−30°	−18	−13
9	29.8	0.5	29.6	..	...	30.1	59.9	"	13.00	0.324	0.216		2.60	−35°	−13°	−21
24	35.7	18.2	5.1	...	...	23.3	59.0	" Laborers at $2.70.	16.00	0.686	0.271	Moving outfit from island to crossing of Falcon River, 7 a.m.-11 a.m.	3.17	+5°	+20°	+18°
25	5.8	...	14.1	...	...	14.1	19.9	"	13.60	0.965	0.683	Fixing pump 12½ hrs.	3.18	+12°	+30°	+28°
26	5.8	...	18.5	...	...	18.5	24.3	"	9.40	0.508	0.387	Fixing pump 14½ hrs.	3.20	+21°	+41°	+32°
27	....	....	....	....	....	....	....	"	2.04	.....	.....	Taking down outfit	3.11	+30°	+45°	+40°
Totals	523.0	45.3	594.2	73.7	31.7	744.9	1,267.9		$404.75							
Average	...	....	....	....	....	27.6	47.0		$15.00	$0.541	$0.319					

CORROSION-RESISTING QUALITIES OF MODERN MILD STEEL vs. OLD-TIME IRON.

By A. T. Entlow.

WITH the marketing of mild steel for various uses, an idea is prevalent that the quality of a corrosion-resisting metal can be determined solely by a chemical analysis showing the percentage of of carbon, sulphate, phosphorus, silicon and manganese present in its composition. While such a standard of selection is to some extent reliable, this basis of determination alone may, and possibly will, lead to many disappointments and unsatisfactory results if adhered to.

While the analysis of a rust-resisting material, showing only to what extent these chemicals enter into its composition, may bear strongly on their ability to resist corrosive influences, it has not as yet been fully or even satisfactorily demonstrated that such a guide can be taken as absolute. Too many other factors enter into the manufacture of such materials, when made through modern processes, to allow of their being disregarded. That this is true will readily be seen by a comparison of modern and early methods and raw materials such as existed when the old-time lasting irons were made.

The idea that the analysis tells the whole story has its origin in the statement so often reiterated when the idea of a modern rust-resisting metal was first conceived several years ago, that "the purer the material as regards the absence of foreign chemical elements, the better would it withstand corrosion." At best this statement only conveys part of the truth.

It might be well, while on the subject, to correct another erroneous idea in connection with the quality of old-time iron, which, if followed in the selection of modern rust-resisting metals, may also lead to trouble. This is the fallacy, that all old-time irons were highly resistant to corrosion. There can be no question that in early days some irons were produced which withstood the ravages of corrosion to a phenomenal degree. This is conclusively proven by many instances of irons, hundreds of years old, still in existence, and by others in a good state of preservation after continuous service in and on buildings for fifty or more years; but because of these specimens, it should not be concluded that all old-time irons were equally good. This is not the case, the samples still extant being merely the survival of the fittest.

While the amount of the foreign elements, carbon, sulphur, phosphorus, manganese, and silicon, in modern rust-resisting metal do have considerable influence on the quality of such a material, no one can say as yet to what extent even a considerable variation in the total amount of these elements, below a certain point, or their relationship one to another, bears to corrosion resistance. This is especially true in the face of such analysis of the old-time irons as did withstand corrosive influences, and which analysis is procurable and on record.

It is impossible to find to-day record of any analysis of these early irons, which compare, even favorably, with the analysis of a good grade of modern mild steel as regards to the low total content of these impurities—and these steels are essentially irons. Yet there is no argument that these old-time irons, so far as corrosion resistance goes, were by far superior to any of the mild steel or irons, made within the last quarter century, at least.

That one material may contain but 4-, 5- or 6-hundredths of one per cent. of these impurities, and another 8-, 9- or 10-hundredths of one per cent. of the same impurities, may not, therefore, prove much of anything. On the other hand, such an analysis of a modern metal, showing that it has been so highly purified, may actually demonstrate just the opposite to corrosion resistance, inasmuch as the vigorous treatment to which the modern metal must have been subjected to so eliminate or free it from these impurities, may have so destroyed its life or vitality that it will not have the power to stand up under the incessant strain of corrosive influences. Further, treatment which is sufficiently vigorous to accomplish such results may actually, and undoubtedly does, add or introduce elements or conditions to the metal which are just as deleterious as the elements which it removes.

The early irons and their manufacturer offer two sources of information on these points on which to base some conclusions as regards the value of analysis as applied to modern-made rust-resisting products. One of these is the quality of the ore, the other the processes by which they were made. Did the good grades of old-time iron get their quality of rust resistance from the ore itself, retaining it through all the different stages of refinement through which it passed from ore to finished product, or was this quality given the finished product by reason of the processes through which the raw materials passed in the course of conversion, regardless of the quality of the raw material?

It has been stated on good authority that the ores from which the best quality of the irons were made, contained a very marked amount of vanadium, the presence of which in the ore was largely responsible for their wonderful qualities. There seems to be no good reason to doubt that this was so, because of the known effects of vanadium as used to-day in connection with the making of some grades of high quality steels. When added to steel, vanadium overcomes the detrimental effects of gases, also adding "vitality" or "life" to the steel. We are further told on good authority that it was not uncommon, in the ores from which these irons were made, to find the phosphorus and sulphur not exceeding .002 respectively. It would seem, therefore, that the high quality of these particularly old irons was due largely, if not entirely, to the high quality of the raw material from which they were made.

The contention or belief, of many, that the corrosion resistance of these irons, in fact of any iron, was due to the presence of slag and cinder in the iron is hardly tenable; otherwise the manufacturer would hardly have worked and re-worked his iron with the avowed intention of getting rid of the slag and cinder to as great a degree as possible. Old-time iron contained slag and cinder because the manufacturer could not entirely eliminate it—not that he wanted it there. Iron is improved by working for this very reason—it rids itself of the slag—and for this selfsame reason such iron commands a higher price than iron which is not so thoroughly worked and contains more cinder.

All these points give a sound insight into the quality of the early raw materials, and point strongly to the supposition that it was from this source that the early irons, when they possessed quality, got it. This is further substantiated when the processes by which these irons were made is taken into consideration.

The Catalan, puddling or other furnaces, in early use, were all limited as regards their effectiveness in removing foreign chemical elements, when compared with the modern high-powered furnaces. With these early furnaces it was impossible to generate a heat of sufficient intensity, or to maintain such a heat for a sufficiently long

period of time, to do more than bring the charge of raw material to a soft or pasty condition sufficient to allow of its being worked. To remove or eliminate most, if not all chemical impurities as found in modern ores, it is necessary to generate a heat sufficiently powerful to reduce the raw materials to a liquid condition of extremely high temperature and to keep it in that state for a considerable period of time. It would, therefore, seem that the furnaces of those early times had little bearing on the subject. What effect they did have was negative rather than positive in that they were not sufficiently powerful to do much eliminating, nor were they powerful enough to produce any detrimental influence on the iron during its purification. It would, therefore, seem that the quality of the old-time iron was due to a condition of favorable circumstances rather than to furnace practice or manipulation. On the other hand, it will be seen that with the modern high-powered furnaces, and modern raw materials carrying high percentage of foreign chemical elements, to produce a high-grade rust-resisting material the question is one of process and metallurgy; and hence the risk of forming an opinion of the quality of a metal on a chemical analysis that only tells part of the story.

Having had the high-grade raw materials with which to work, it was not necessary to subject them to any severe furnace treatment thereby destroying the vitality of their product or injecting into them gases or other elements of a detrimental character.

The fuel used in these furnaces is often given credit for the superior quality of these irons, but this idea is largely erroneous. Charcoal, the fuel used exclusively in the early years of iron making, had little or no bearing on the subject, only inasmuch as this fuel being extremely pure and free from sulphur or other detrimental elements, the iron in the course of refining or while in contact with the fire, could not absorb any additional injurious chemical element to its detriment from the fuel employed.

Comparing modern furnace practice and modern raw materials which are high in carbon, sulphur, phosphorus, silicon and manganese, it is evident that the manufacturer who undertakes to produce even as good an analysis as was found in the early lasting irons, must subject his raw materials to a far more vigorous treatment, and in so doing the product must be affected in some way. That this is true is conclusively proven by the quality of the mild steel or irons produced since the introduction of the high-powered Bessemer and open hearth furnaces, notwithstanding the fact that the products of these furnaces show a better analysis, as regards purity, than the early irons.

So far as chemical analysis goes, the one striking difference between old-time iron and modern mild steel lies in the difference in the amount of manganese and sulphur present, particularly the former. The presence of greater quantities of these two elements in the one metal and the smaller amount in the other, undoubtedly has considerable to do with the difference in their corrosion resisting qualities.

It is true that, due to the absence of carbon, sulphur, phosphorus, silicon and manganese, or their elimination to the lowest possible degree, the evil of segregation is guarded against, and segregation from any cause, as proven by recent research, bears strongly on the question of corrosion, if it is not the whole cause of this evil.

Segregation in the metal produces differences of potential, and corrosion is merely the passing of the metal into solution, through electrolysis. Differences of potential may occur through elements or conditions other than by the presence of carbon, sulphur, phosphorus, silicon and manganese and may be introduced into the metal both during and after the process of purification. The fact has been pretty well demonstrated that it is very probable in reducing these foreign chemical elements to an extreme degree in order to overcome segregation, this very thing happens. It is also more than probable that in so reducing these impurities, due to the vigorous treatment necessary to accomplish this result, the vitality of the metal is destroyed, and though the material may show a phenomenal analysis, so far as the chemical impurities are concerned, it will be lacking in the necessary vitality to withstand the constant and incessant attack of corrosive influences. This further goes to show what may happen when selection is made by chemical analysis alone, so far as modern products are concerned.

The difference between ancient and modern processes, in that the one affects the metal by injecting detrimental elements during the process of refinement, while the other did not, is fully demonstrated by comparison of both practices. That this is so is fully demonstrated, if in no other way, by the fact that quite large quantities of manganese are added to the metal in both Bessemer and open hearth practice for practically no other purpose than to eliminate the oxygen absorbed by the metal, during the process of refining while in the furnace. This, by the way, is the exact time or point at which iron ceases to be iron and becomes steel—when the manganese is added. The addition of manganese or any other foreign chemical or mineral was never resorted to in the making of old-time iron by the early processes, such treatment being entirely unnecessary to make it commercially useful.

Unfortunately, while manganese is an excellent material with which to get rid of the undesirable oxygen, it is in itself most objectionable, in that it is to a large extent, if not wholly, at the bottom of the corrosion trouble, so far as foreign elements are concerned. This is borne out by the fact that high-grade early iron carried little more than a trace of manganese, while modern mild steel contains anywhere from one-fifth to one-half of one per cent. of it.

Apart from the question of how much or how little the effects of foreign chemical elements are on the question of corrosion resistance, the physical qualities unquestionably have very much to do with this question, if reliance can be placed on the physical properties of such of those old-time irons as have proven their worth after many years of service.

The density of these old irons seems to have entered into the question of their corrosion-resistance, inasmuch as the specific gravity of these irons ran as high as 8 and sometimes over, while that of modern mild steel is given as 7.85, though it is doubtful if it will generally run this high. In other words, a cubic foot of old-time iron would weigh on this basis, 500 pounds or more, while the weight of a cubic foot of mild steel would weigh about 490 lbs. This would indicate an entirely different physical structure in regard to the number and size of the crystals forming these two metals.

Another striking difference between these ancient and modern metals is shown in their fracture. When broken, the iron showed itself decidedly fibrous at the fracture point, while the steel at the point of breaking is decidedly crystalline. This shows that the crystals of the iron were held together so tenaciously by a force which may well be called "vitality" that before they would separate or give way, they drew out into fibres or strings, while the steel fails before the crystals are in any way deformed. This would indicate that, though the steel is a purer metal, the effect of the process by which it was made has been to

destroy in some way, mechanically or chemically, the "vitality" of the steel, which may be, and in all likelihood is, the very quality necessary in either steel or iron to enable it to withstand successfully the attack of corrosive elements.

Through the findings of investigators which, if correct, and there is no good reason to doubt but what they are, we are informed that steel made from the high-grade old-time irons stands a much better dynamic or vibratory test than modern-made steels, except some special steels such as made from vanadium. This further emphasizes the fact of the superior "vitality" of the old irons. Further, there is every reason to believe that these irons themselves would stand a like test to a far better advantage than modern mild steels which have proven so susceptible to corrosion. This lack of "vitality" may be due to the presence of the greater amount of gases in the modern steel which are decidedly detrimental to metal. It is, therefore, safe to say that the longer raw materials are subjected to the influence of the modern high-power refining furnaces to reduce or eliminate the high percentage of foreign chemical elements in them, the richer will the purified metal be in gases detrimental to quality. In other words, as the impurities are reduced, the gases are increased and in modern mild steel making it is on this account that manganese, which is itself highly susceptible to corrosion, is employed.

Physical structure due to working, forming, reheating and cooling, must also not be overlooked in connection with this question of corrosion. Much depends on the handling of the metal while being transformed into finished products. Investigations all prove that any mechanical treatment which sets up uneven strains within the metal will induce corrosion. Improper heating, sudden cooling or working the metal at a wrong temperature produces this result and so induces corrosion even in a pure homogeneous metal. The crystalline formation of any metal, iron or steel, has much to do with its ability to withstand corrosion. The smaller and more regular and closely knit the crystals the better will the metal resist disintegration. Hard or soft spots due to improper distribution of carbon, or to any other cause, also invites corrosion. Anything that destroys the natural crystalline formation of the material or breaks down the crystals has a like effect. Iron or steel reduced too rapidly in rolling or worked at too low a temperature will have its crystalline formation upset or destroyed. Straining metals in this or other ways tends to make them more porous, which is another condition which invites rapid corrosion. The crystals in a properly made iron or steel, lie in the direction of the heat waves, passing out of the metal during cooling, and any treatment that in any way interferes permanently or destroys the natural formation or relationship of the crystals one to another, tends also to the destruction of the metal by corrosion. Compare the modern forced methods of to-day, whose tendencies are to introduce into the metal so many causes of corrosion, both in the furnace and mill practice, with the slow deliberate and careful methods of handling in the days of the early iron making practice and it is readily seen that any analysis which gives only the amount of carbon, sulphur, phosphorus, silicon and manganese present may prove very misleading and disastrous when used as a basis on which to judge its corrosion-resisting qualities.

From the foregoing it will readily be seen that in connection with a rust-resisting metal made under modern conditions, a chemical analysis of the carbon, sulphur, phosphorus, silicon and manganese may mean much or little. While such a material may have corrosion-resisting qualities as well as a very low content of these chemical elements, it is quite possible for it to give such an analysis and yet be anything but a high-grade rust-resisting material.

It is in this respect that a metal may excel, in that while its analysis may be lower, all things being considered, than other analyses, this analysis is not attained at the sacrifice of vitality or other qualities essential to any metal which is to show rust-resisting qualities equal to those of the early irons which were rust-resisting.

Both in the furnace practice and in the mill practice, absolute care must be taken that no detrimental elements accompanying the refining process remain in the metal. In the mill practice, the metal should be handled with extreme care and attention in the heating, rolling, cooling, and other processes through which it passes while being made up into the finished product. In consequence, the physical structure of the metal is not likely to be permanently destroyed, and by careful and intelligent heat treatment, any strains or other defects are eliminated which may possibly have appeared in the metal, homogeneous as regards chemical elements—practically free from detrimental gases and physical or mechanical strains—without sacrificing that element of vitality which is essential to any metal that is to be subjected to the severe corrosion-producing conditions of modern times.

TIMBER AND FERRO-CONCRETE PILES PATENTED.

A combined pile of timber and ferro-concrete has been patented by an Austrian engineer. The main object of the patent is to utilize the timber portion in the position where it will be safe against decay, and the concrete portion where it will not be exposed to disintegration by the chemical attack of unfavorable soil or water. As timber piling is known to last indefinitely when permanently below the water line, the timber section is driven down in the ordinary way till its head is one metre above water line. Previous to driving the head is rounded and a wide steel band fixed on. The head is now lifted off and a steel tube substituted somewhat conical in a downward direction. Within this steel tube is now slipped a ring wedge, strongly made with six ribs, and this wedge is driven into the head of the pile, thereby forcing the timber to spread and take the form of a cone fitting tightly the conical inside of the steel tube. The head of the wooden pile and the steel tube are thus firmly compressed together, after which both can be driven, by using a suitable head piece for the tube, to any further desired depth. Reinforcement may now be placed within the tube and concrete filled in, completing the joint and the concrete pile. In a combined pile of this sort the whole of the driving can be done with the ordinary [illegible] for timber piles, and the difficulty of placing ferro-concrete piles in boggy or marshy land is obviated. Where great length of piling is necessary this construction has been proved to have many advantages.

The Penn Iron Mining [illegible] a good grade of square braided hemp packing after experimenting with [illegible] packing for high pressure, 8-stage centrifugal pumps. [illegible] the stuffing box [illegible] the full pressure occurs, in this case, 522 lbs. Since the shaft has [illegible] longitudinal, there is nothing to distribute the pressure [illegible] packing to the other [illegible] up. Consequently, the outside ring is likely to be pressed too tight and wear a groove in either the shaft or the protecting sleeve on the shaft. No attempt is made to lubricate the packing, the [illegible] stuffing [illegible] two hours.

NOTES OF A HYDROGRAPHIC-TOPOGRAPHIC SURVEY.

By J. A. Macdonald, Hermanville, P.E.I.

THE following notes pertain to a survey which the writer made on the shores of the Gulf of St. Lawrence, on the north coast of Prince Edward Island, and which is indicated in Fig. 1. On such a survey, being a combination of hydrographic and topographic work, a surveyor finds it advantageous to have his party consist of about four men, in addition to himself. It is often found best to employ men for the hydrographic work who live in the locality and are, therefore, familiar with the management of boats, etc. There is little advantage in employing men with considerable previous experience except, perhaps, in the case of the recorder. Frequently the surveyor himself acts as recorder. Generally, one man can adequately look after this work. Then the chief requires two to act as rod men, while the principal assistant should be able to take observations simultaneously with the chief surveyor.

The equipment should include a sextant together with a transit or two compasses. The transit should be supplied with stadia hairs, as stadia readings will greatly facilitate the work. A stadia rod, or ordinary level rod, [illegible] or tape will also be found useful. The other equipment, such as buoys, sounding rods and lines, boats, range poles, etc., will depend largely on the work to be performed.

Making the Survey.—The fixed points of reference for the survey are usually located on shore, but sometimes buoys are anchored off the shore and used for this purpose. All such points should be accurately located from some measured base whose azimuth has been found. The traversing work for the location of the fixed points of reference differs in no sense from that of a topographical survey, for such a survey is usually connected with a topographical survey of the adjacent shores or banks, the triangulation scheme serving both purposes.

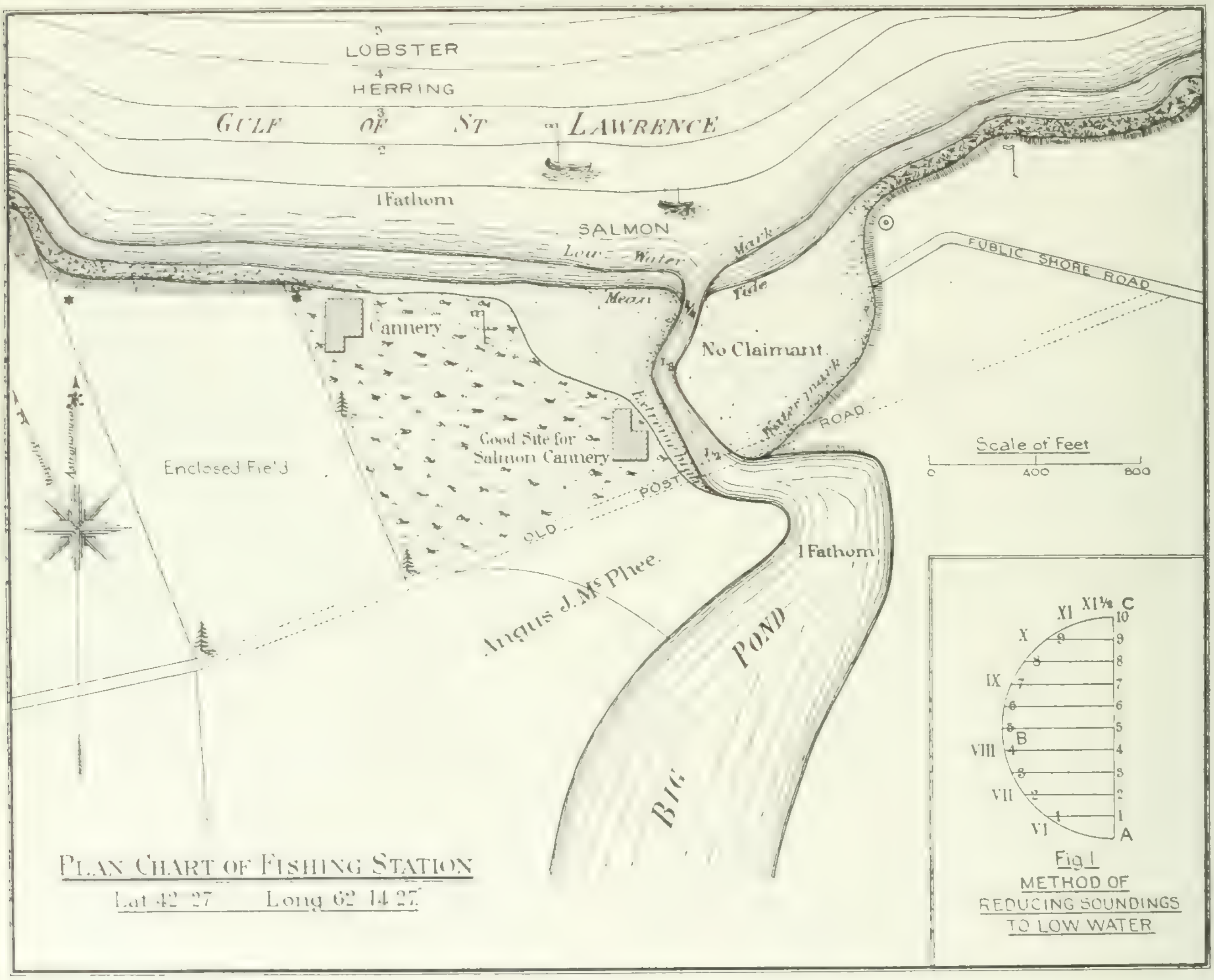
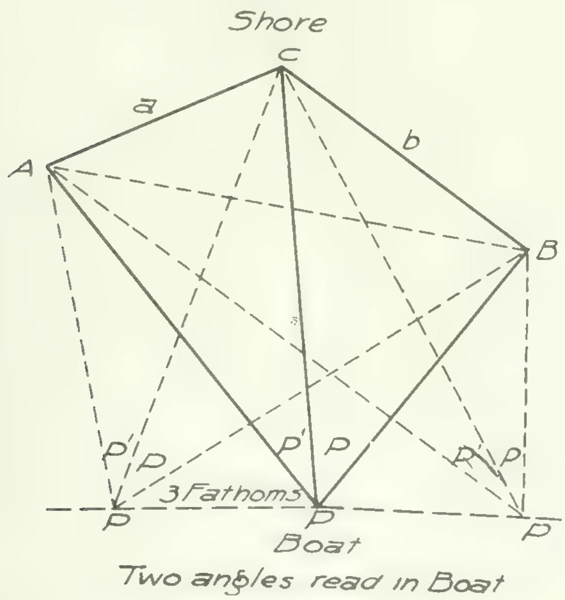


Fig. 1.

A complete traverse is first made of the shore lines at the various stages of the tide. The defining of the tide lines for plotting may involve the work being postponed for several days or weeks. It is important to get the mean tide marks. This is sometimes difficult, and one will need to watch the changes of the moon's phases. Soundings are taken by some surveyors at low tide, but it is now more common with hydrographic surveyors to take the soundings at mean tide. Close observation is needed to get the lines of low tide. High tide need not be looked for, as the high-water mark can be readily determined by the markings on the land, and a traverse made along the lines of those marks will determine its location. The banks will also have to be accurately tra-

versed. All roads, public and private, used or unused, need to be traversed and accurately plotted on the plan or chart. All farm lines and fences are to be measured and shown in their true position. The declination of the magnetic meridian should also be plotted. All of these are shown in the plan herewith (Fig. 1).



$$PAC = \text{Cot} R \left(\frac{a \text{ Sin } P'}{b \text{ Sin} P \text{ Cos} R} + 1 \right)$$

$$\text{when } R = 360 - (P + P' + C)$$

Fig. 2.

Methods.—The location of soundings can be found with reference to visible known points by two angles read at fixed points on shore, as in Fig. 3; or by two angles read in the boat with a sextant (Fig. 2). These are the two principal methods used in work of this kind. Supplementary methods of various kinds are usually brought into use, such as (1) by taking the soundings on a certain range and reading one angle either on shore or in the boat, or by both; (2) by sounding along a known range, or line, taking the soundings at known intervals of time; (3) by taking the soundings at the intersections of fixed range lines; or, (4) by means of chords or lines stretched between fixed points. These methods are variously adapted to different conditions.

Two angles read in the boat to three points on shore whose relative positions (see Fig. 2) are known. This is called the 3-point problem. Let A, C, and B be the three points on the shore defined by the two distances a and b and the angle C. Let the two angles P and P′ be measured at the point P. The problem is to find the distance AP and BP.

The angles are read in the boat with a sextant. There are several methods of solution of this problem, e.g., analytical, geometrical, mechanical and graphical solutions. The latter will only be dealt with here, though the formula for the analytical solution is given in the figure.

The angle may be laid off on tracing paper or tracing linen by lines of indefinite length, and this laid upon the plot and shifted in position until the three radial lines coincide with the three stations, when their intersection marks the point of observation. This is the most ready method of plotting such observations when no three-armed protractor is at hand.

This method has many advantages. In the first place, only one observer is required; there is no time lost in changing stations, and there cannot be any misunderstanding in the work. A large number of points, P, can be taken with the three-station points, A, B and C, on shore. The contour, or fathom-lines, 1, 2, 3 and 4, can all be taken, in a great many cases, in three or more positions, to or from the three points on shore. It is well to check the graphical solutions now and again by the trigonometrical method of solution.

Two Angles Read on Shore.—If two instruments, transits or compasses, be placed at two known points on shore, as A and B, Fig. 3, and the angles subtended by some other fixed point and the boat be read by both instruments when soundings are taken, the intersection of the two pointings to the boat, when plotted on the chart containing the points of observation duly plotted, will be the plotted position of the sounding. This method requires two observers. When there are long lines of offshore soundings to be made, and no fixed point on shore of sufficient distinctness to be observed with the sextant from the boat, this method must necessarily be used. The instruments should both be pointing to zero previous to taking an observation. Ordinary surveyors' compasses answer for this work quite well, though the transit is certainly the more accurate.

A triangulation system along a rocky shore or coast may consist of one line of stations or poles on shore and a corresponding line of buoys. The angles are read only from the shore stations, two angles in each triangle being observed. Good results are obtainable from this method if the weather is calm. If the length of any line in this system is known the rest can be determined by the ordinary methods of plane trigonometry.

Soundings on Fixed Cross-sections in Rivers.—The methods described are only usually adapted to sea soundings, and are not adaptable to river soundings. In the chart (Fig. 1) a river is shown, depths or soundings, accurate direction of flow and outline of banks given. Manifestly a different operation was found necessary for obtaining the river soundings, as well as its slope. In

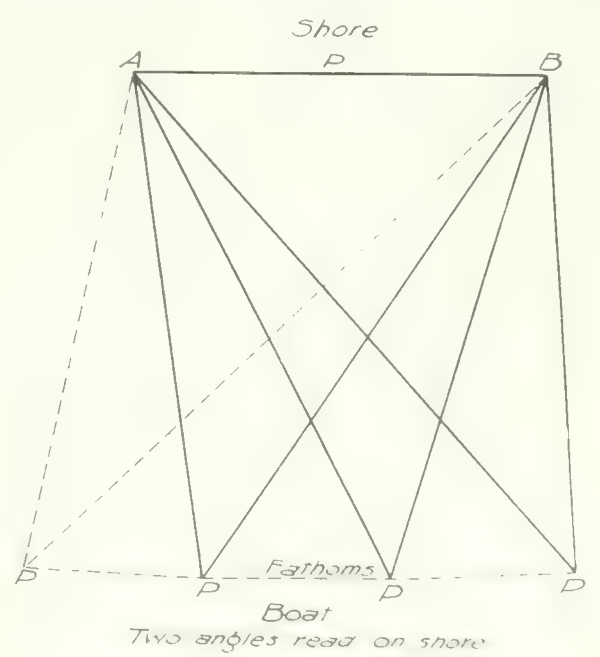


Fig. 3.

this case it is found best where the same section is to be sounded a great many times and where it is desirable to obtain the successive soundings at close juxtaposition, to fix range posts on both sides of the river, and then one or more series of intersecting ranges at points some distance below or above the section on one or both sides of the river. The soundings can be made at the same points continuously without having to observe any angles. Such a system is shown in Fig. 4. AA and BB are range poles on the section line across the river. O and O' are poles set at convenient points on opposite sides of the river, both above as well as below the section when found necessary. The poles OO' should be distinguishable by small flags. Shorter posts are set near the bank at points 1, 2, 3, etc., in such positions that the intersections of the lines O-1, O-2, O-3, etc., with the section range BB will locate the soundings at the various points of the cross-section line AA, BB. This method is very simple and effective. It is plain that by changing the position of the poles OO' several cross-sections can be taken at different points on the river without changing the position of the posts, 1, 2, 3, 4, 5, 6, 7, 8, or the base AB.

Making the Soundings.—The weight of a sounding lead will depend largely on the tide or current. A lead of 5 lbs. answers for still or shallow water, though for deep running stream, or very strong tides, a weight of 20 lbs. may be required. The line should be of a size suited to the weight, and may be composed of ordinary hemp or manilla. The line should first be well stretched for a couple of days, so as to be freed from all kinks. It is quite possible to stretch a line too much, as they are apt to shorten by use when over-stretched. Soundings at sea are always taken in fathoms (6 feet). On the United States lake surveys it is the general practice to indicate all depths over 24 feet in fathoms, and depths under that in feet. The depths here shown are all in fathoms, as was the old custom in hydrographic work. "½" and "¼" shown in this map meaning one-half and one-fourth fathoms, or 3 feet and 1½ feet respectively. If the line is graduated in fathoms and fractions of fathoms, leather tags are fastened in the strands of the line at the fathom points, and the fractional fathoms, as ¼, ½, are indidicated by cotton or woolen strips. The line should be frequently tested.

Sounding poles are found most convenient and necessary. They should be used when the depth is less than 12 feet. A pole 15 feet long will answer for obtaining 2-fathom soundings and under. The pole may simply be graduated to feet, or, where great accuracy is required, to tenths.

In tidal water the elevation of the mean tide is the plane of reference for both the topographical and hydrographical surveys, and the state of the tide must be known with reference to the mean. The elevation of the zero being determined, with reference to mean tide water, all soundings must then be reduced before they are plotted to what they would have been if made at mean tide. This can be done graphically by Bourcher's method, as shown in Fig. 1, if necessary. This is seldom necessary, as practically all soundings are now reduced to mean tide.

Lines of Equal Depth.—These lines correspond to the ordinary contour line on land, as shown in all topographical surveys in rough and mountainous countries. To draw lines of equal depth with certainty the elevations of many more points are necessary than are needed for drawing contour lines on a railway map, for example, because the bottom cannot be viewed directly, while the ground can. Where the ground is seen to be nearly level no elevations need be taken, while for a similar region of bottom a great many soundings are required to prove that it was not irregular.

River slope is a very important part of a survey where a river is involved. Sometimes it may be desirable to determine it for a given stretch of river. In ascertaining the discharge of streams it is often found necessary to set gauges simultaneously every few minutes for several hours. But such an object was not required in this case under consideration, where, as for ordinary purposes, the river slope was determined with sufficient accuracy by simply reading the level or stadia rod at the water-surface as the survey proceeded. In all natural channels the slope is quite variable. For short distances it is frequently negligible, as the water is still and almost level, then follows for a short distance a sudden fall or rapid. Streams, particularly those emptying into the sea, are subject to material changes in local conditions. This applies also to streams flowing in friable, sandy beds. Great caution must be exercised in introducing the function of river slope into any hydraulic formulæ for natural channels.

NEW TYPE OF EMBANKMENT WALL.

THE Dominion Government has awarded a contract for four thousand square yards of a new system of armour for the protection of the dyke at Laprairie, Que., against damage from water and ice of Lake St. Louis. This contract was placed with C. Gardaix and A. C. Attendu, C.E., of the Decauville Flexible Armour of Canada, Montreal, who are the owners of the Canadian patents on the Decauville flexible armour.

This armour, which was patented in France seven years ago, is intended to take the place of concrete retaining walls for the protection of river and other embankments. The armour consists of a network of cement bricks. These bricks are held together by vertical wires, which pass through corresponding holes in the bricks. The bricks are absolutely equal in size, and measure about 10 in. in length by 3 in. in width by 5 in. in height. Each brick has two holes through which the wires pass. These wires are attached to a strong horizontal steel cable running along the bottom of the embankment, and forming the base line of the whole wall.

Each brick is curved at the ends in such a manner as to form hinges with the next bricks, so as to permit of flexibility. The wires, about one-fifth of an inch in diameter, are heavily galvanized—180 grams to the square meter. Eight wires are used per running yard of brick, thus allowing a tension of about seven thousand pounds per yard of brick. The wall is held in place by its own weight and by large stone or iron anchors which are sunk into the earth at the top of the embankment, the ends of the vertical wires having been twisted together in strands, and the strands bound around the anchor.

The bricks are made of cement and sand by presses driven by hand or motor power. A pressure of about twenty-three tons per brick is obtained. Mr. Attendu states that the resistance of the bricks against crushing is about nineteen hundred pounds per square inch. Staircases of any width desired can be placed in the wall by a special arrangement of the bricks. It is stated that the cost of the Decauville armour is from thirty to fifty per cent. less than a concrete wall of the same height, length and resistance.

RELATION OF THE TECHNICAL PRESS TO THE GOOD ROADS MOVEMENT.*

By Hyndman Irwin, B.A.Sc.,

ENGINEERING literature has as important a mission to fulfil in the field of highway work as it has in any other line of municipal or national development. It would not be difficult to substantiate a claim that it bears a much heavier responsibility here than in other phases of engineering work. For, in the road movement, as we of the present generation are obliged to regard it, we have many transitory practices to supplant, many precedents to uphold and many innovations to establish. The principles of dynamics, unchanged, of course, are served up in new and dissimilar ways, because of the variableness of traffic, climate and quality of materials. Generally speaking, each piece of work differs in several essentials from every other. The problem of making a dollar do the most work has innumerable counter-claims and conditions attached to it.

The successful engineer of to-day is necessarily a most diligent consumer of engineering literature. It is the most valuable instrument at his command. By it he acquires a knowledge of the experience and findings of others. To the highway engineer this knowledge is quite indispensable, particularly at this time when we are in the throes of revolutionary tendencies occasioned by the co-mingling on our thoroughfares of diversified methods of travel, heavier loads, increased speeds in every season, over arteries of commerce and pleasure fed by longer and more numerous tributaries than ever before. It is the lot of the road expert to strive constantly against the repellency of nature and the added negative influences of the transportation of man and his effects. The question of expenditure seldom allows him a conquest that is forceful and positive, but he is obliged to be satisfied with a compromise which is temporary and in need of constant vigilance. He cannot expect his own personal judgment and experience to carry him over all the difficulties of his work. In fact, without a knowledge of the experience of others he is unable to judge from an economic standpoint the success or failure of his own. Modern highway improvement and maintenance do not entirely submit to old and well-defined principles that, once inculcated, serve for all time. New methods, new machinery, new materials, up-to-date organization and management—these are vital points in the foundation upon which the good roads movement of to-day depends. Without a working knowledge of them the road man is not suitably equipped for his work. This knowledge, however, can be acquired in a sufficiently comprehensive degree in only one way—through the pages of the technical press.

In dealing with the relation of the technical press to the good roads movement one must include under the general title not only periodic literature, such as technical and trade journals, bulletins, proceedings of engineering and road organizations and reports of governmental departments, but also books, pamphlets and catalogues. They are all of value to the road expert. From catalogues, for instance, he obtains information respecting new machinery and appliances, their general construction, capacities, efficiencies and costs. This information is a very important asset, as the problems of road construction, maintenance and repair, from the viewpoint of the road superintendent, are largely a matter of machinery, and are rapidly providing steady employment for men who have had a training in mechanical work. Likewise the publications of producers of road materials contain information scientifically compiled and arranged in a manner that admits of ready assimilation without material effort or study. Government books of records and statistics of physical and climatic conditions, reports of official tests, etc., are of great value. In short, there are many elements of the technical press which should be included. It is the purpose here, however, to refer to the class of technical literature for which the road man is obliged to pay money, viz., books and periodicals, and define their degrees of usefulness in the general establishment and upkeep of road systems.

With the publishing houses pouring forth an avalanche of new books, it is, perhaps, opportune to observe that there are many classes of books, as well as many books on road engineering and administration. This applies, of course, to literature of all descriptions, but as at this juncture of the road movement so much dependence is to be placed on written thought, attention may well be called to its varying qualities.

Books may be based upon right or wrong theories; they may describe good or poor practice; they may be well or poorly written. Their contents may consist of old material in new garb, or valuable and unpublished facts in unreadable form. Books may be evenly balanced, smoothly written, comprehensive treatises of principles, or they may be misleading and unreliable accumulations of jumbled notions. How often we find in our libraries two books on the same subject, one a veritable interest-binder, and another as difficult to read as a blue book on banking statistics. Again, a book may be abnormally padded with the apparent view of approaching the size of a higher-priced volume, while its antithesis is found to possess, in concise and logical manner, thoughts that are exceptionally clear and every thought in its proper sequence with its antecedent.

Comparatively few road men have large sums to invest on the literature pertaining to their work, but when a man on the job wants information of a technical character he generally wants it badly, and he is not generally so located that he can examine the reference books in the library or the samples on a publisher's shelves in order to ascertain whether or not the information he desires is contained in the books which would there be presented to him for examination. Not every man knows, moreover, just what the information which he desires to secure will entail in the matter of such examination. Book-purchasing under these circumstances bears a marked resemblance to the old-time horse trade, in so far as hidden qualities are concerned. The book purchaser, however, is not distrustful of the author or publisher, and is more likely to infer that the book is a good one, else it would not have been published. The circulars descriptive of the scope and qualities of the published work should naturally be expected to bring out the good points which it may possess, but other features, perhaps undesirable, may be quite overlooked. It is to be remembered that among the very reputable publishers of engineering works, even the best are not immune from misjudging a manuscript which may, when published, prove to fall very short of expectations, and to be unauthentic in some of its important statements.

Evidently the selection of sources of technical information is an important one to the road expert. Briefly, the reviews of newly published books, to be found in the

* Extracts from paper read at the First Canadian and International Good Roads Congress, Montreal, May 20th, 1914.

recognized technical journals, have gradually become, through a process of evolution, beginning with a general rehash of the author's preface, an unprejudiced and straightforward summary of the scope and fundamental features which a book may possess. Journals that devote space to them are cultivating the practice of careful criticism. The result is noticed in the discrimination on the part of the publisher in the matter of sending books to these journals for review. The publisher who desires to increase the sale of an unlikely book would rather have it left unreviewed than severely criticized; hence, the reader may safely increase his dependence upon the books which are reviewed in such journals, provided the review discloses an indication of the sort of information he is after.

The value of keeping up-to-date in technical reading cannot readily be overestimated. This is so widely recognized that little reference need be made to it here. There are books on roadwork that are out of date in many of their statements before they have been in print for five years, or even less. Th growth of road literature as a result of new types and new methods is a fair example of the varying tendencies of general practice. In order to keep pace, therefore, with the new developments in the field of road-building it is necessary to be in touch with the best technical literature of the day on the subject.

Reverting to technical periodicals on roads a century ago, they were practically non-existent. Since then the inception of numerous local and national organizations, with their proceedings devoted to papers and discussions presented in their meetings, and the birth of scores or more of technical journals, also of thousands of trade publications issued by manufacturers, have more or less adequately responded to the need for the broadcasting of information.

Evidently there is the necessity for careful selection on the part of those having to do with this movement and its literature. No man can read by any means all of the information which is presented. Yet the old saying that "experience is the best teacher" was never truer in any line of industry, it being universally accepted, of course, that no man can ever expect to achieve success if he depends solely on his own experience for enlightenment. It is upon the experiences of others, as already stated, that he very largely depends, and in the record of such experiences lies the reason for the existence of the technical press. The technical journal benefits its readers by conveying to them first-hand the sort of information that is not yet to be found in the pages of treatises on the subject. It outlines methods of doing work that are newer and better than others. It describes the maiden efforts of machinery, tools, and processes recently devised. It thoroughly investigates the achievements of progress, and endeavors to present them in the most acceptable way for the general good of mankind. It is, therefore, an indomitable factor in the equipment of the man associated with the good roads movement.

The problem of culling from the growing mass of road literature that which he needs most is an important one for the road engineer. To illustrate its extent we may refer to the recently issued Good Roads Year Book for 1914 of the American Highways Association. It is found to contain a section devoted entirely to a summary of articles published in 1913 in the various journals devoted to the movement. It lists over 650 articles published in that year alone, besides innumerable bulletins, circulars, pamphlets and documents. Evidently there is plenty of material with which a man may equip himself, but a wise selection is a difficult matter.

Of course, the roadman is not alone on the problem. The publishers of this information are fully aware of it, recognize its importance, and are endeavoring to present the desired information in such a way that he can readily make practical use of it. The rest devolves upon himself, and in this age of specialization the problem is not without serious difficulties. The roadman is unwise if he limits the scope of his reading to that which satisfies his immediate needs, and them alone. A man interested therein is also interested in methods of surveying, drainage, construction of dams and bridges, mechanical operation of machinery, transportation of materials, use of cement and concrete, geology of rocks and clays, and the road laws of the country. Manifestly, there is no defining line between his work and that of men in numerous other phases of development. Therefore, if a road engineer is judicious and discreet he will read that literature which pertains to his own special work—and much more.

Finally, there is the important question of the preservation and filing of technical literature. This applies chiefly to periodicals. Once in a while the road man may be unable to peruse his journals as he would like owing to press of duties. He may glance over an article that promises to be of value to him, but is obliged to lay it aside for further consideration, and it may be misplaced or forgotten. The obvious solution lies in the method adopted by almost every up-to-date engineer in other lines of work—that of carefully examining the journal when it is received, and having all articles that have a bearing upon his work listed in a card index system. In a few years every phase of work with which he has to do will be well represented. If he has been wise he will have had his periodicals bound. He is then equipped with a library of information that is of the greatest value to him. He may, for instance, meet a problem which requires additional knowledge of sub-drainage. His card index immediately brings before him a summary of all the information on the subject that has been published by his journals since he began the system, and reference to the articles indicated places him in possession of the required data. They are not the opinions of one man, but of many. Moreover, they are not from an early edition of a volume that has since been succeeded by others which may not be in his possession. He has all the information of intervening years before him. His is not necessarily a voluminous and costly library, but one that is ready to serve him well in more ways than one. Besides acquainting him, on the publication of each issue, of the new methods and new machinery just sprung into use, and of road activities in other countries and in other sections of his own, his periodicals if used in a scientific manner, soon create a reference library for him of excellent quality that can be added to at small cost as years go on, the whole system thereby becoming more valuable.

A principle which is applied by furnace foremen for judging the grade of matte and sometimes also in judging the furnace, is by the fracture of the small sample usually taken at the time of tapping. At the Old Dominion smelting works at Globe, Ariz., the components of the furnace charge are exceedingly variable and often result in abrupt changes in the running of the blast furnaces. Slag samples are taken by a small shallow ladle and are approximately the size and shape of the usual matte sample at most smelting works. The slag "buttons" from each furnace are arranged by the sampler in regular order in a small tray and the foreman judges by the microscopic characteristics of the fracture whether a furnace demands attention. It has been found that the old employees become excellent judges of the fractured slag sample and the system is a great convenience on the night shift.

MINE TUNNELING.

DURING the past few years great progress has been made toward safer, more efficient, and more economical tunneling methods. This advance is partly due, no doubt, to the recent increase in the number of tunnels and adits driven for developing and draining mines and transporting ore. The United States Bureau of Mines, during 1911 and 1912, made a special examination of this phase of mining operations, in connection with an investigation of mining methods and means for preventing accidents. The details especially studied were the provisions for the safety of employees, the kinds of equipment, the methods of driving, and the cost of construction. The results and conclusions obtained from that investigation are discussed and summarized in Bulletin 57, of the Bureau. It is entitled "Safety and Efficiency in Mine Tunneling."

This bulletin is confined chiefly to a discussion of tunnels and adits for mining purposes, such as drainage, transportation, or development, but it also discusses those used to carry water for power, irrigation, or domestic use, in which essential features are practically identical with mine tunnels.

Most tunnels of the sort discussed are driven through rocks at least fairly hard in contrast to ordinary soil, quicksand, and other heavy material of a treacherous nature, and practically none is driven through recent river-bed deposits. Therefore, descriptions of the special methods and equipment for tunnel work in such materials are omitted. A distinction is made between tunnels or adits for which the excavation is wholly or in a large part in material containing no ore and those that follow a vein. As far as possible, the discussion is limited to the former, because the methods employed in driving along a vein are usually more akin to the distinctive operations for removing ore and are, therefore, not so apt to be good examples of tunnel practice.

It has been suggested by prominent authorities that the word "tunnel" be restricted to the designation of such nearly horizontal passageways as extend completely through a mountain or hill from daylight to daylight, and the words "adit" and "drift" be used only for nearly horizontal galleries that enter from the surface and serve to drain a mine or furnish an exit from the workings but do not continue entirely through the hill. Such definition is eminently desirable from strict technical consideration, and would contribute to precision of usage, but, although the suggestion was made over thirty years ago and has been repeated several times since, such usage is not widely established. The American practice of referring to any horizontal gallery as a tunnel, without regard to whether it extends completely through a hill, is so firmly fixed in mining literature and among mining men in this country, even being embodied in the United States mining laws, that the use of a more precise definition has been thought scarcely justifiable in this report.

AMERICAN INSTITUTE OF CONSULTING ENGINEERS.

A meeting of the Institute will be held at 55 West 44th Street, New York City, Thursday evening, June 11th, 1914, at 8 p.m. The special order of business will be the question of "A Memorial to Alfred Noble"; also Consideration of Changes in the Constitution and By-laws, recommended by the Special Committee appointed at the last annual meeting.

Coast to Coast

Montreal, Que.—Towards the end of the last week in False Creek have been practically completed.

Liscombe, N.S.—The cost of construction of the lightship, Halifax No. 19, which was recently wrecked off Liscombe, N.S., was $175,000. The contractors were Bow, McLaughlin & Co., of Glasgow, who were under contract to deliver the vessel complete at Halifax.

Montreal, Que.—The thirteenth annual report of the Montreal Light, Heat and Power Company shows substantial gains in gross revenue and net earnings. The gross revenue was $6,245,697, an increase of $736,141, and net earnings amounted to $3,467,246, an addition of $286,130.

Victoria, B.C.—It has been stated by Mr. D'Arcy Tate, vice-president of the P.G.E. Railway Company, that contracts have been awarded for the grading of that line from Fort George to Lake La Hatch, which means that construction will now be carried on from the coast to Fort George.

Ottawa, Ont.—The Dominion House of Commons passed estimates on May 24 for the department of public works amounting in all to approximately $25,000,000. Appropriations for public buildings amounted to $15,250,000. Of the sum, $4,500,000 was for buildings in Ontario. All the estimates for river and harbor improvements with the exception of those in Ontario and Quebec were passed.

Montreal, Que.—Towards the end of the last week in May, it was expected that the "break up" or excavation of the upper part of the C.N.R. tunnel at Montreal would be completed in that part of the work actually under the mountain; and a new stage in the construction reached. Excavation work will still have to be completed, however, in the portion of the tunnel underlying the city streets and for about 700 feet at the west portal. The site for Mount Royal Heights station is also being excavated.

Trent Canal, Ont.—The estimated cost of the new work on the Trent Canal for which tenders are now being called, e.g., Section 3, is placed at $1,500,000. The section to be enlarged lies between Peterboro' and Lake Simcoe. It has been announced by the minister of railways and canals in the Ottawa House that the entire canal will be finally completed at the increased depth within 4 years. The present contracts are all under way; the lower sections between Hastings and the Bay of Quinte will be opened for traffic this autumn.

Fredericton, N.B.—It is stated that the I.C.R. freight sheds at Fredericton are among the best along the entire system, both in size and equipment. The building is a wooden structure, 304 feet in length and 30 feet wide, and can accommodate 10 cars at once. Seven switches run into the sheds with a possibility of more being constructed. The equipment at the new freight sheds is entirely new. There are two excellent loading and unloading platforms and one machinery platform, the last being used to load and unload heavy machinery.

The Pas, Man.—Work commenced on May 25 on the grade upon which steel is to be laid to the terminal grounds of the Hudson Bay Railway. Beginning at a point south of the big bridge across the Saskatchewan river, at The Pas, two tracks will be laid, one to the round-house to be located at the foot of Eighth street, and another to connect with the C.N.R. about a mile south of the present station of that road. By June 1, steel is to be at the site of the proposed round-house and active work is to be continued until winter. The plans call for 14 tracks with a capacity of 1,600 cars. Eight of these tracks will be laid at once. As necessity requires the others will be installed.

Montreal, Que.—The result of a test made at Montreal of the emergency water supply from the Lachine canal has been to show that the emergency plant has proven a complete success. It will now be possible at any time to turn the water out of the regular supply conduit, examine the cement work and make any necessary repairs without affecting the city's supply of water. During the time the water was pumped from the Lachine Canal, tests were made every half-hour and the results were found to be quite satisfactory. While not as pure as the regular river supply, it was found that the difference was not of great consequence. The official tests of the canal water used showed an average of 2,000 bacteria per cubic centimetre. The regular city supply is 800 per cubic centimetre.

Montreal, Que.—Among other offers which have been received at Montreal for the underground electric light service along several streets of the city, is one from the Montreal Public Service Corporation which is being placed before the civic board of control. For a term of 6 years, the company supplying everything, the price per lamp would be $137 as compared with $156 by the Light, Heat and Power Company of Montreal. For a contract of 16 years, the Service Corporation offers the lighting at $88 per lamp under the conditions mentioned as compared with $96.40 by the Light, Heat and Power Company. Again, if the city supplied the lamp standards, cables, etc., for a contract of 16 years the price per lamp would be $65, which is about $5 lower than a similar offer by the Light, Heat and Power Company.

Fort William, Ont.—Improvements nearing completion at the city dock of Fort William are making a change in the appearance of that place. A rip-rap retaining wall has been built around the railway embankment, and a roadway has been constructed from the subway to the freight sheds, with a foundation of large rock and a surface of crushed trap. The road is to be improved further when the railway company allows of the widening of it by 7 feet by building a concrete retaining wall for the railway tracks. The sidewalk below the tracks has been widened and the subway is to be roofed with corrugated iron sheeting. Anticipating that the railway company will make further permanent improvements here, this will be the extent of the city work for the present, leaving the balance to be done when the city and railway company have agreed upon what shape the permanent work will take.

Regina, Sask.—It is said that 139 miles of wire will be required for this year's program of electric light construction at Regina. While a good deal of this wire will be required for the construction of feeders from the new power house, at the same time provision is being made for a good many miles of new service in all directions from the city. New poles, which have been purchased, will, when set up, carry 24 miles of single strand wire. Without taking into consideration the cost of labor, an expenditure of $81,456.47 has already been authorized for this year's extensions to the distributing system; and of this sum $53,381 will be spent on wire alone, the balance providing for all the other materials required in the construction of an electric light distributing system. The program for this year's extension provides for 1,000 new services for light and power, as well as for 200 new street lights.

Varennes, Que.—It has been stated that the big brick plant at Varennes, Que., near Montreal, of the Mount Royal Brick Company, Limited, which will be the most modern brick manufacturing plant in the world, and the largest under one roof in Canada, will be in operation before the first of June. The plant will have an output of 120,000,000 bricks per annum. It is claimed, moreover, that the clay belt which the Mount Royal Company possesses at Varennes has been tested in almost all the laboratories in America, and that these tests have proved that the quality of brick made from this clay has greater strength than that of almost any other building brick in the market. Again, the brick machinery, with which the plant is equipped, is so perfect, that from the time the steam shovels take the clay out of the ground, until the brick is delivered on cars, or in barges, in the city of Montreal, they are only handled once, the entire process of manufacture being performed by automatic machinery.

Ottawa, Ont.—Supplementary estimates totalling $17,438,912, which have been tabled in the Dominion House, have augmented the main estimates of expenditure to $208,174,088. Items included in the supplementary estimates are $1,000,000 towards the construction of a government railway to connect Montreal with the Transcontinental, $1,887,100 for new rolling stock and further improvements to the I.C.R., $1,000,000 as a further vote to the Transcontinental railway, $1,000,000 for the Quebec bridge, $1,000,000 for the Welland ship canal, $50,000 for improvements to the banks of the Rideau canal at Ottawa, a revote of $10,000 for Ottawa fuel-testing, roasting building, addition to shed, etc., $500,000 for the harbors of Port Arthur and Fort William, $500,000 for Quebec harbor, $200,000 for the new postal station "A" on St. James street, Montreal, $250,000 for Hamilton harbor works, $100,000 for the Goderich harbor, $40,000 for Port Credit, $58,000 for Nigger Island channel, and $655,000 to complete St. Lawrence dredging plants.

Winnipeg, Man.—A recent report, submitted by J. G. Glassco, manager of the Winnipeg light and power department, to the civic board of control for the fiscal year ending April 30, shows a surplus for the department amounting to $80,000. There was an increase of 50 per cent. in the gross billings for the year, the total for 1912-13 being $638,081.73 as compared with $953,882.88 for 1913-14. The net realizable earnings advanced from $544,736.03 to $842,368.42, or 55 per cent., while the net cash receipts increased from $520,760.67 to $809,966.74, or 55.8 per cent. For the fiscal year ending April 30 last year there was a deficit of $83,432.90. However, the department was allowed for the first 2 years of operation, to charge the deficit up to capital account, but it had to show an actual profit in the third year if a three cent rate for current was to be maintained. The surplus of $80,000 for the second full fiscal year will ensure the maintenance of the three cent rate. In 1912-13 the number of kilowatt hours generated was 39,071,750, as compared with 60,271,385 for 1913-14, an increase of 54 per cent.

Hamilton, Ont.—Hamilton has been considering the purchase of a stone quarry, and members of the board of control have made an inspection of the Dunlop farm with a view to the purchase of this as a civic quarry site. Also the Canadian Quarries, Limited, has offered to sell its plant and property for $65,000, or to enter into a term contract for the city's entire requirements at 85 cents per ton, f.o.b., Hamilton. The latest development in the project is an offer from the Canadian Crushed Stone corporation, proposing an agreement which would give the city an interest of $150,000 in the company's quarries and ensure a constant supply of stone at a reasonable price. The city would be required to enter into a 15-year contract for its entire requirements at $1.00 per ton, f.o.b., Hamilton; while, by entering into an arrangement along these lines, it would mean that if the company, for any unforeseen reason, was compelled to go into liquidation during this 15-year period, the city through the bond ownership or guarantee would become the absolute owners of the quarry plant for $150,000.

Vancouver, B.C.—More than 10 bridges are being constructed over the Thompson river along the line of the C.N.P. railway; and rapid progress is reported. Nearly half of the upper part of bridge No. 1, the structure at Cisco, has been erected and the big span over the river is being built.

The Cisco bridge is about 6 miles below Lytton, and is the first crossing from the Port Mann end of the line. It passes over the C.P.R. tracks at this point. More than half of bridge No. 2, about half a mile west of Lytton, has been constructed and work is now proceeding on the west shore span. Bridge No. 3, a short distance east of Lytton, has been practically finished, with the exception of a big girder which is to be laid when the track is extended. Bridge No. 4 at Basque, No. 5 at the Black Canyon, and Nos. 6 and 7 near Ashcroft, have all been erected. The foundations of two bridges close to Kamloops have been laid; and work on the superstructures will be proceeded with when track is extended. Bridge No. 10, three miles above Kamloops, has been finished. On the section north of Kamloops work has also been well advanced. The foundations for the big trestle bridge over Lyon Creek at Mile 123 have been laid; and preparations are now being made for the erection of the superstructure. Track-laying will be proceeded with when the Cisco bridge is ready for traffic; and then the various gaps on the sections north of the present rail-head will be linked up right through to Kamloops.

PERSONAL.

D. C. A. GALARNEAU has been appointed forester to the Algoma Central and Hudson Bay Railway, with duties which will include supervision of the railway's fire protection system.

W. R. WORTHINGTON, engineer in charge of the sewer department of the city of Toronto, has been appointed to act as examiner in this district for the Royal Sanitary Institute of Great Britain.

C. R. YUILL, successor to Nather, Yuill & Company, of Vancouver, is consulting engineer for the city of Armstrong, B.C., and has just completed plans for the construction of four reinforced concrete bridges for the city.

G. R. BLAIR, who for some time past has been assistant to T. R. Fulton, Ontario manager for the Eugene Phillips Electrical works, Limited, is acting as manager for Ontario pending the appointment of a successor to Mr. Fulton, resigned.

C. L. HOWSE, E.E., of Hamilton, has been appointed manager of the hydro-electric and waterworks systems of Peterborough, Ont., and will begin his duties on July 1st. Mr. Howse has had considerable previous experience with the Hamilton Hydro-Electric Department.

H. L. BROWN has, it is announced, been recommended to the appointment of assistant city engineer of Winnipeg to succeed the late R. D. Willson, who, as our readers will remember, was electrocuted while on a trip of inspection over the city's artesian well system last fall. Mr. Brown has been in charge of the wells.

AGENTS WANTED.

A well-known British manufacturer of sewage disposal apparatus is anxious to get in touch with responsible individuals or firms in Canada who would be in a position to act as their agents and be able to influence business on their behalf.

A British firm engaged in the manufacture of dynamos and motors is anxious to appoint Canadian agents for the sale of their apparatus in this country.

Fuller particulars regarding the above inquiries can be had by corresponding, in the first instance, with Mr. J. J. Salmond, Managing Director, *Canadian Engineer*, 62 Church Street, Toronto.

A NEW SLIDE RULE IMPROVEMENT.

A new patented indicator or runner for slide rules, called the "Frameless" has just been perfected by Keuffel & Esser Co. Every figure on the rule is clearly visible at all times,

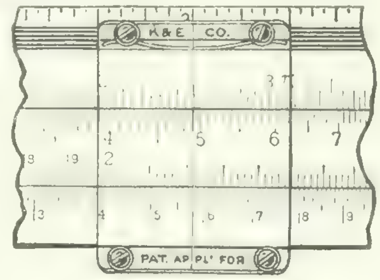


Fig. 1.

there being no side pieces to the metal holder of the glass indicator, and therefore, nothing to hide any of the figures on the rule (see Fig. 1). This is one of the most important improvements in slide rules—those indispensable instruments for rapid calculations.

Many times, after setting the old style indicator or runner, the user would find that he could not read the result because important figures were hidden by the frame or holder of the glass, (see Fig. 2). Frequently two, and sometimes, four or more figures would be thus hidden; causing more or less inconvenience and uncertainty in reading the slide

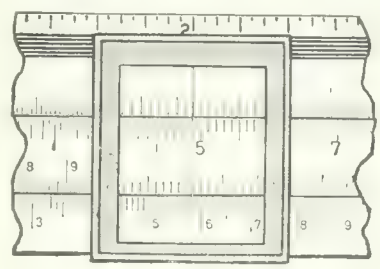


Fig. 2.

rule. The new runner entirely obviates this difficulty, and vastly increases the ease and rapidity of using the rule,

Thousands of engineers and scientists in every profession and industry, as well as contractors, builders, architects and merchants have found the slide rule invaluable as a time and brain saver in quickly and accurately making a great variety of calculations. In its various forms, it has been adapted to the needs of practically every line of work, including all branches of engineering, as well as chemistry.

The 6th International Congress of Mining, Metallurgy, Engineering, and Economic Geology, will be held in London July 12th to 17th, 1915. The Congress will be divided into sections corresponding to the above. The last Congress was held at Düsseldorf in 1910.

Word has been received by the Hon. Louis Coderre, Minister of Mines at Ottawa, to the effect that a British company with a Canadian connection, the Oil Processes, Limited, is going to spend a sum in excess of $2,000,000 in a systematic and exhaustive search for petroleum in Northern Alberta.

The blast furnaces at the Washoe Works, Anaconda, now have water-jacketed tops. Riveted-steel jackets proved unsatisfactory. The best form has been found to be cast-iron jackets, about 2½ in. thick, the iron being cast around a grid of 1¼-in. pipes, connected by U's at the ends, the individual pipes being about 1 in. apart.

ORDERS OF THE RAILWAY COMMISSIONERS
OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21854—May 22—Approving location Edmonton, Dunvegan and B.C. Ry., through Tps. [illegible], Rgs. [illegible], W. 5 M., Alberta.

21855—May 22—Approving location Edmonton, Dunvegan and B.C. Ry., through Tps. 74-77, Rgs. 18-19, W. 5 M., Alberta.

21856—May 22—Extending collecting and delivery limits of Express Companies in town of Outremont, Quebec.

21857—May 23—Dismissing application Tp. Cleveland, Que., for Order apportioning cost of work on crossings of highways by G.T.R. about 3 miles east of Richmond Station, by closing crossings and diverting road to north-east and along G.T.R. right of way.

21858—May 22—Directing G.T.P. Branch Lines Co., divert crossing, as constructed, mileage 13.6, across its tracks; that Co. open up north and south road allowance as well as east and west road allowance across its tracks, mileage 8.5. Work be done 60 days from date of this Order; cost be borne by Ry. Co.

21859—May 23—Dismissing application Federal Electric and Manufacturing Co., of Montreal, Que., for Order extending collection and delivery limits of Express Companies in said city.

21860—May 19—Dismissing complaint Superior Sand and Gravel Co., Limited, of St. Gabriel de Brandon, Que., against rate charged by C.P.R. on sand and gravel from St. Gabriel de Brandon to Montreal.

21861—May 22—Dismissing application J. H. McPherson, Tp. Beverly, Ont., for Order directing C.P.R. to construct, maintain, operate siding from main line to premises of Applicant, Lot 32, Con. 7, Gore of Puslinch, Co. Wellington, Ont.

21862—May 23—Directing C.N.R. to reconstruct fence between Drumheller and Calgary, Alta., within 2 months from date of this Order; work be done to satisfaction of Engineer of Board.

21863—May 23—Authorizing Mun. Council, village Beauport, Que., to construct 2 highways over railway of Quebec Ry. Light, Heat and Power Co. in village of Beauport, Que.

21864—May 23—Authorizing C.P.R. to construct, at grade, additional track (double track) of main line, Farnham Subdivision, across Champlain St., town of St. Johns, mileage 19.9, Co. put back sidewalk as it was before construction of said crossing and reinstate original grade. Rescinding Order No. 21714, dated April 29th, 1914, authorizing temporary crossing.

21865—May 20—Directing that, within 60 days from date of this Order, C.P.R. install improved type of automatic electric bell at crossing of Albert St. at Alliston, Ont., 20 per cent. of cost of installation of bell be paid out of "The Ry. Grade-Crossing Fund," remainder by Ry. Co., all train movements on sidings be flagged over crossing by trainmen of said Railway Company.

21866—May 20—Directing that C.P.R. install gates at St. Maurice, St. Thomas and Bonaventure Sts., city of Three Rivers, Que., 20 per cent. of cost of installation of gates at each crossing to be paid out of "Ry. Grade-Crossing Fund," remainder by Ry. Co., cost of operating gates be paid ¾ by Ry., ¼ by city of Three Rivers.

21867—May [illegible]—Amending Order No. 21691, dated April [illegible] 1914, by adding figures "[illegible]" after figures "[illegible]" in third line [illegible] of Order.

21868—May [illegible]—Dismissing application of William Watters for Order directing G.T.R. to take his property on Ferguson Avenue, City of Hamilton, Ont.

21869—May [illegible]—Rescinding Order No. 14064, dated September [illegible], [illegible], in connection with lumber rates from Routhier, Que., to Montreal, for export.

21870—May 26—Suspending tariff of Duluth, South Shore and Atlantic Railway, C.R.C. No. 331, pending hearing to be held at Ottawa on June 16, 1914, when Duluth, South Shore and Atlantic Ry. Co., and C.P.R. will be required to show cause why said tariff should not be disallowed.

21871—May 23—Authorizing G.T.R. to reconstruct Bridges Nos. 239, Mile Post 209.45, 12th Dist., Tp. Himsworth, Dist. Parry Sound, near Powassan, and No. 247, Mile Post 222.12, 12th Dist. Tp. Ferris, Dist. Nipissing, near Nipissing Jct., Ont.

21872—May 23—Authorizing C.N.R. to construct spur on lane in Block 81 and 120, Regina, Sask., from point on authorized spur in Block 82, old plan 33, and described as subsidiary spur No. 4, with an extension thereof across 6th Ave. and down land in Block 141, and cross Cornwall St. and 5th and 6th Aves., Regina.

21873—May 26—Authorizing Lake Erie and Northern Ry. to construct, at grade, across Air Line Division and Georgian Bay and Lake Erie Division of G.T.R. at Station 1281.58, town of Simcoe, Ont., subject to certain conditions; Applicant Co. to bear and pay whole cost of providing, maintaining, and operating said interlocking plant.

21874—May 23—Approving and authorizing clearances of proposed awning on Toronto Dairy Co.'s premises in city of Woodstock, Ont., subject to company's undertaking to keep employees off tops and sides of cars when operated over spur at Toronto Dairy Company's premises.

21875—May 23—Authorizing C.P.R. to operate trains over bridge No. 144.8 on Portal Sub. Div., Sask. Division.

21876—May 26—Approving detail plans of C.P.R. showing proposed overhead crossing at Eighth Ave. West, Moose Jaw, Sask.

21877—May 26—Directing that Canadian Northern Express Co., publish and file joint tariffs showing express rates on fruit and vegetables from company's shipping point in Prince Edward County to points beyond or via Smith's Falls, reached jointly by said company and Canadian Express Co., or Dominion Express Co., that shall not exceed rates on said commodities published by Can. Express Co. and Dominion Express Co. from Niagara Dist. to same points.

21878—May 28—Directing that C.P.R. provide cabin close to crossing at Cherry St., Toronto, on south side of railway and west side of street, properly heated, and furnished with windows giving clear view up and down railway for more than a block in each direction, for use of flagman to protect public using crossing between hours of 6.30 a.m. and 7 p.m.

21879—May 26—Relieving C.P.R. from providing further protection at crossing of highway second east of Green Valley, Mile Post 47, Co. Glengarry, Tp. Lancaster, Ont., Con. 8, Lot 30¾.

21880—May 26—Authorizing C.P.R. to construct road diversion in Sec. 14, Tp. 11, R. 10, W. 3 M., Sask., and company is authorized to construct, by means of grade crossing, its Swift Current South Easterly Branch Line across said diversion.

21881—May 26—Authorizing Montreal and Southern Counties Ry. to construct across four (4) highways in village and parish of St. Cesaire, Co. Rouville, Que.

21882—May 26—Authorizing G.T.R. to operate its trains jointly with C.P.R. (1) over sidings for E. W. Gillett Co., Limited, south of Liberty Street, Toronto; (2) over tracks of C.P.R. on north side of Liberty St. and lying between point on Liberty St. on which joint tracks of Applicant and C.P.R. end and diamond crossing on Jefferson Ave.

21883—May 26—Authorizing G.T.R. to construct siding into premises of Dominion Foods, Limited, St. Catharines, Ont.

21884—May 26—Authorizing Dist. South Vancouver, B.C., at own expense, to construct Main St. over Vancouver and Lulu Island Ry. in Municipality of South Vancouver, B.C.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

DEAD WEIGHT AND LIVE LOAD

SOME COMPARISONS OF WEIGHTS AND CAPACITIES IN THE FREIGHT AND PASSENGER SERVICE OF RAILROADS IN CANADA, GREAT BRITAIN AND UNITED STATES.

By GEORGE SHERWOOD HODGINS, A.S.M.E.,
Assistant Engineer (Mechanical Department) National Transcontinental Railway.

WHEN one drops a letter into a post-box he seldom reflects that part of what he pays for with the two-cent stamp is really to facilitate handling, and has nothing to do with the subject of his communication. An ordinary business man's envelope for "letter-size" paper is probably about one-twelfth of an ounce and each sheet of paper is possible one-sixteenth of an ounce in weight. It therefore happens that one envelope may contain fourteen sheets of paper, and the whole be below the one ounce which goes for two cents. If this proportion is true, the weight of the envelope is to its contents as 1 is to 14, or, roughly, about seven per cent.

When it comes to the ratio of dead weight or tare to capacity or live load or paying weight, in connection with railway cars, the same style of reasoning applies. The vehicle is the envelope and the paying load is the letter, and the more "letter" you can send and the less "envelope" required the better you are off, because you have less "incidental" expense in the matter. The tare and capacity of cars used here and in the United States differs from those of Great Britain, because the kind of traffic and the method of handling commodities in the countries differ very considerably.

Here and in the United States, the traffic is carried most frequently in box cars, which are permanently roofed and weather-proof. Rough freight or heavy materials are carried in gondolas or on flats. The haulage of shipments of coal, ore or other rough freight often takes place in localities where a huge consignment is carried for long distances without breaking bulk. Freight carried in box or refrigerator cars is best handled where "car-load" lots are insisted on, so that the vehicle may "earn" as much as possible when in service.

In the United Kingdom freight traffic approximates more to what we would call a "magnified express business." A merchant in Manchester, for example, may order a small consignment from a London house, perhaps by wire, and expects his goods to reach him on the following day. Knowing that he can get what he wants on short notice, he probably keeps only a small stock on hand in any case, and the railway company must handle this kind of business without attempting to hold their wagons for "car-load" lots. In fact, the 10-ton capacity goods wagon in England carries, on the average, about three tons.

A year or so ago, a writer in the "American Railway Number" of the London Times, said that "the modern freight car carried 2½ times its own weight and a train of the largest freight cars will transport to the sea-board the product of 5,000 acres of wheat fields." This is, of course, a splendid performance, but the cars carrying 2½ times their own weight have a percentage of tare to contents of 40 per cent. This is much above the post office rate, but it must be remembered that the paper envelope in the mails only makes one trip and is then destroyed, whereas the railway vehicle goes over the road many times and carries a large number of consignments before being relegated to the scrap heap.

Bulletin No. 31, issued by the Bureau of Railway Economics at Washington, D.C., gives the increase of freight car capacity as 28 tons in 1902, up to 36 tons in 1910. This is an increase of a ton a year. The increase has been brought about by the growth in the volume of business in the United States, and the appearance of steady improvement, then apparent, gave rise to the humorous couplet:

"Dear little box-car, don't you cry,
You'll be a freight-house by and by."

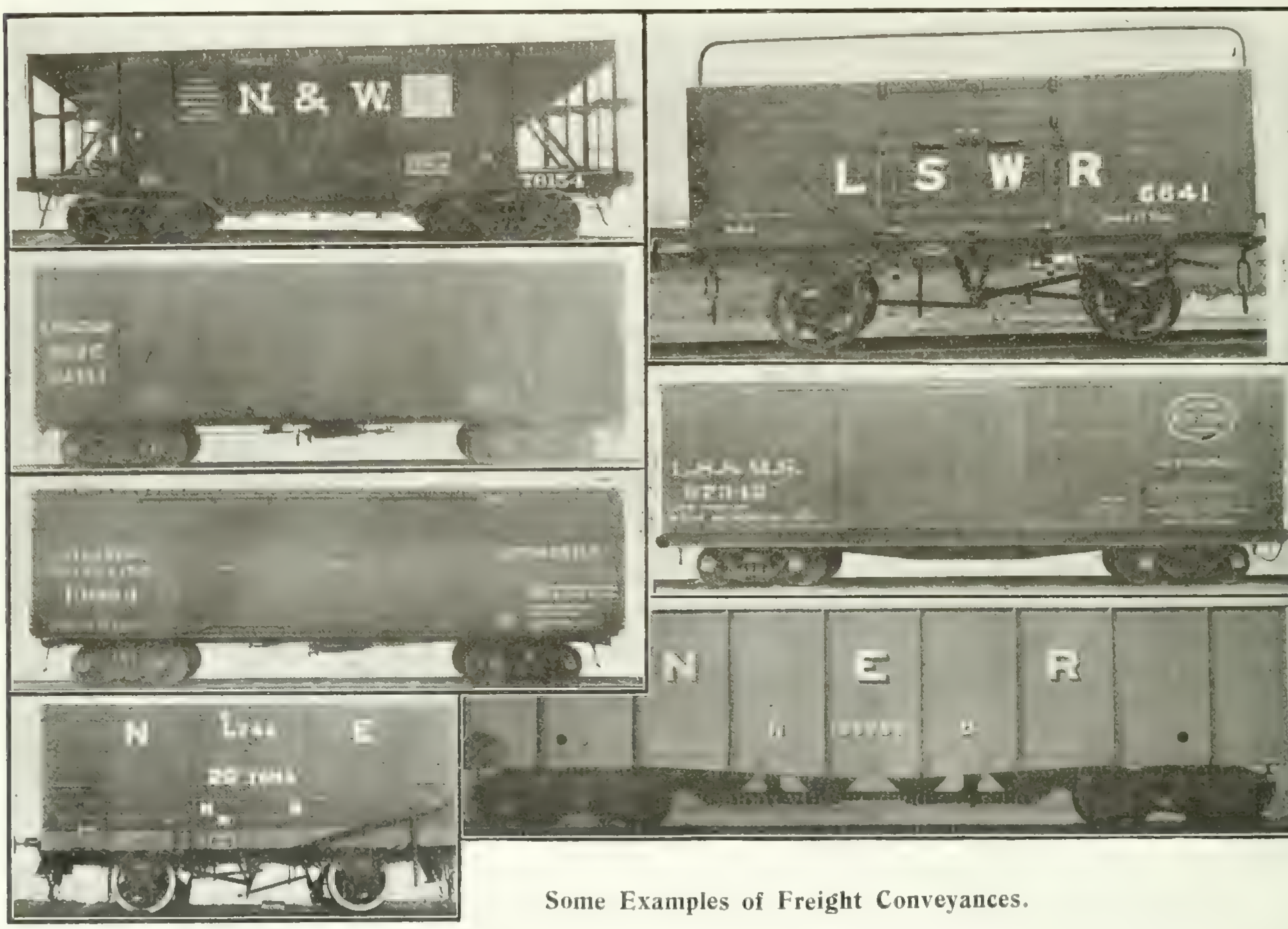
The freight-house on wheels, however, never materialized and much of the prosperity of the Republic was destroyed by laws directed against railroads, enacted by State legislatures which were dominated by a spirit hostile to the "common carrier." There is, however, a reasonable prospect of the return of good times this year.

Our illustrations show, among others, some modern examples. A Norfolk and Western high-side steel hopper gondola, No. 76154, has a capacity of 115,000 lbs., and the tare weight is 41,800 lbs. This gives a ratio of "envelope" to "letter" of 36.3 per cent. The North-Eastern Railway of England, with an open steel wagon, No. 100090, like our gondolas, has a capacity of 40 long tons, or 89,600 lbs., and a tare of 16 long tons, 1 cwt., or 35,840 lbs. This gives a ratio of dead weight to paying load of 40 per cent.

C.P. Box No. 104554, when similarly examined, is seen to have a capacity of 80,000 lbs. and a tare of 38,300 lbs. This gives a ratio of tare to load of 48 per cent. London and South-Western open goods wagon No. 6641, of 15 tons capacity, 33,600 lbs., and tare of 14,784 lbs., gives a ratio of tare to load of 44 per cent. A.C.L. Box 130064, used for the carriage of automobiles, has a tare of 38,000 lbs. and a capacity of 60,000 lbs. The ratio between the two is, therefore, 63 per cent. It must be observed that this is what might almost be called a special car, as an automobile takes up space rather than weight.

A Great Western Railway of England, 10-ton covered goods wagon (shown as nearly as may be, by a L.T. and S.E., somewhat similar vehicle) has a tare of 15,232 lbs. and capacity of 22,400 lbs., and gives a 68 per cent. ratio. Erie Box 107831, with tare 40,200 lbs. and capacity 80,000 lbs., gives a ratio of dead weight to load of 50.25 per cent.

North-Eastern Railway of England open goods wagon No. L. 742, with tare 20,048 lbs. and a capacity of 20 long tons or 44,800 lbs., gives a ratio between the two of 44.75 per cent. L.S. & M.S. Auto-Box 67342, with a tare of 39,000 lbs. and capacity 80,000 lbs., shows a ratio of 48.75 per cent., and London, Tilbury and South End Railway (English) open 10-ton goods wagon No: 1411, with tare 13,272 lbs. and capacity 22,400 lbs., gives a proportion of dead weight to live load of 50.0 per cent.



Some Examples of Freight Conveyances.

(1) N. & W. high-side steel hopper gondola; capacity 115,000 lbs.
(2) C.P.R. box car; capacity 80,000 lbs.
(3) A.C.L. box car (automobile doors); capacity 60,000 lbs.
(4) N.E.R. (English) open goods wagon; capacity 44,800 lbs.
(5) L. & S.W.R. (English) open goods wagon; capacity 33,600 lbs.
(6) L.S. & M.S. box car (automobile doors); capacity 80,000 lbs.
(7) N.E.R. (English) open steel goods wagon; capacity 89,600 lbs.

In these examples we have five Canadian and United States and five British vehicles, and though they are not strictly comparable, because each differs widely in certain particulars from the others, yet a rough and ready comparison may be attempted. The total capacity of the five Canadian and United States cars is 415,000 lbs. and the aggregate tares amount to 197,300 lbs. The ratio of aggregate tare to aggregate capacity gives a percentage of 47.54; and in like manner the five British goods wagons show an aggregate capacity of 212,800 lbs., and the aggregate tare is 99,176 lbs., giving an average of 46.60 per cent.

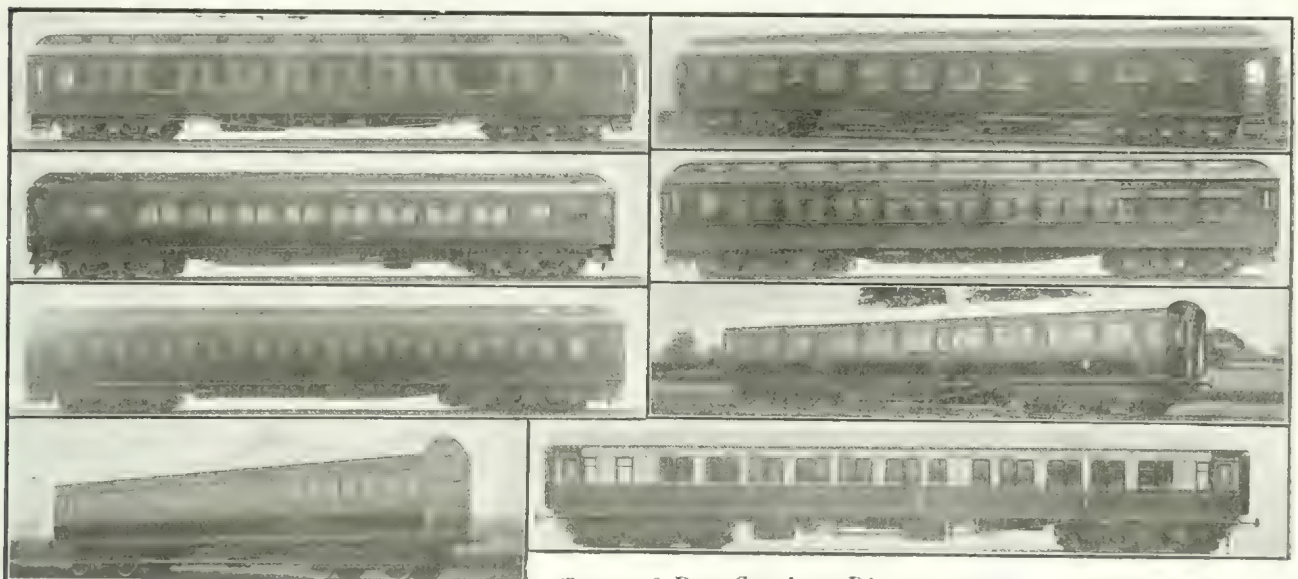
In these two cases there is not much to choose from, but it may be remarked that the Canadian and United States cars contain much greater volume than do those of the United Kingdom, and the former are subject to interchange among the various roads, a practice almost unknown on the other side of the water. This tends to increase hard usage. Weather conditions here are more severe, and everywhere shunting on this continent is far more detrimental to cars than it is abroad. The percentages stand almost even, but with the larger business done here, under severe conditions of service, against the handicap of snow, cold, more numerous grades, sharper curves, and with the strains incidental to long trains and heavy engines, the actual "work" done by the American freight car, carrying more weight per vehicle, cannot be accurately determined by the simple survey of the mathematical ratio representing the proportion of dead weight to live load.

When day coaches and sleepers are taken into account, it is at once obvious that value of the paying "load" cannot be computed by weight, either physical or "moral." It is usually determined by the distance travelled and the accommodation provided. All persons

are considered as practically equal and one dollar as good as another. The relative seating capacity, when compared with dead weight, varies with each coach and in each country. The "value" of each traveller in terms of "pound-miles" is not anything like as uniform a method of rating as the distance passed over or the "dollar-equal-dollar" system would seem to indicate. In other words the dead weight hauled per passenger becomes an important item when the mileage of each coach comes to be made up for a year of continuous service. There are certain things done by railways which cost money and weight and space, which have for their sole object the hope of attracting business, such as the observation platforms on certain coaches or the introduction of library cars on trains. From a purely transportation point of view these things are useless, but as "business-getters," they may be very effective adjuncts.

New York, New Haven & Hartford sleeping car No. 2070 is all wood. The body weighs 99,600 lbs., and the trucks together weigh 44,000 lbs., or a total of 143,600 lbs. There are 16 sections and at night there is accommodation for 32 persons. As a day-coach, which is its maximum load, 64 persons can be carried, and taken this way, a dead weight of 2,243 lbs., for each passenger, is hauled over the road.

The Canadian Pacific Railway sleeper "Granite" is all wood and has two six-wheel trucks, which taken together weigh 40,400 lbs. The body weighs 90,800 lbs., making a total of 131,200 lbs. There are twelve sections, each capable of carrying four persons when the car is used in the day time. Allowing for four persons in the drawing room, the dead weight per passenger is 2,523 lbs. Intercolonial railway sleeper "Sydney" has ten sec-



Types of Day Coaches, Diners and Sleepers of Various Railways.

(1) C.P.R. sleeper "Granite"; weight, 131,200 lbs; carries 52 day passengers.
(2) N.Y., N.H. & H.R.R. sleeper; weight, 143,600 lbs.; carries 64 day passengers.
(3) N.Y.C. day coach; weight, 142,600 lbs.; carries 84 passengers.
(4) N.E.R. (English) bogie, third-class carriage; weight, 64,400 lbs.; carries 80 passengers.
(5) Intercolonial sleeping car "Sydney"; weight, 130,000 lbs.; carries 44 day passengers.
(6) M., St. P. & S. Ste. M. day coach; weight, 126,500 lbs.; carries 76 passengers.
(7) N.E.R. (English) corridor composite dining saloon; weight, 91,840 lbs.; carries 26 passengers.
(8) G.W.R. (English) sleeper; weight, 93,632 lbs.; carries 12 night passengers.

As a typical example of a modern day-coach, first-class, New York Central Lines (Big Four) No. 751 may be considered. This car is an all-steel vehicle, mounted on two six-wheel trucks. The body of the car by itself weighs 98,500 lbs. and the trucks weigh together 44,100 lbs. The total weight on the track is, of course, 140,600 lbs., and seating capacity is provided for 84 persons. There is, therefore, 1,697 lbs. dead weight for each passenger, supposing the car to be full. Another day-coach, No. 991, on the Minneapolis, St. Paul & Sault Ste. Marie, is a coach with steel exterior and wooden finish, seats, etc., inside. The car body weighs 84,000 lbs. The pair of six-wheel trucks together weigh 42,500 lbs. and the vehicle stands on the track weighing 126,500 lbs. and can carry 76 persons. The dead weight per passenger in this case is 1,664 lbs., which is very close to that of the Big Four coach just mentioned. The average, when the weight of the two cars are added together, for the 160 passengers carried by them, is 1,680 lbs.

tions and a drawing room. As a day-coach, i.e., with all available space filled, there is comfortable room foı probably 44 persons, and estimating the total weight of the car at 130,000 lbs., a dead weight of 2,954 lbs. per passenger is hauled.

The sleeping cars here enumerated have together a gross weight of 404,800 lbs., and carry, when each is full up to maximum capacity, an aggregate of 160 persons. The average dead weight per passenger then becomes 2,523 lbs. This is practically equal to the Canadian Pacific sleeper "Granite," which thus represents a typical case.

British passenger rolling stock presents some interesting varieties, though comparison with Canadian and United States coaches is difficult, owing to a variety of circumstances. The Pullman car has been introduced into Great Britain but has never been popular. This is not due to any idea of inferiority of design, equipment or

comfort, but because the English do not care to travel "in bulk," if one may so say, when they are able to pay for the comparative privacy of the compartment. This is no more an example of prejudice than is the preference of the people of the United States, who do not care to be "penned up" in small groups. People on both sides of the Atlantic are gradually modifying their likes and dislikes, as the British are now willing to dine all together in a restaurant car while on the rail, and the traveller on this side is not altogether adverse to the "boudoir" car.

Midland Railway (English) corridor composite (1st and 3rd) No. 2865, weighs 67,720 lbs., and carries 34 passengers. It therefore has a dead weight per passenger of 1,992 lbs. London and South-Western Railway (English) corridor composite (1st and 2nd) coach No. 859, weighs 64,400 lbs., and carries 34 passengers, thus giving a dead weight for each of 1,894 lbs. North-Eastern Railway (English) No. 838, (all 3rd class) weighs 53,312 lbs., and carries 80 passengers. The dead weight for each is 666.4 lbs. These three coaches have an aggregate weight of 185,432 lbs., carry in all 148 passengers, and have an average dead weight per person of 1,252 lbs.

Great Western Railway (English) corridor sleeping car No. 9082 (all 1st class) weighs 93,632 lbs. and accommodates 12 persons. Its dead weight for each goes as high as 7,803 lbs. It is interesting to note from the engraving that this vehicle has the words "sleeping car" on each side. The word "car" is apparently beginning to be used in Great Britain to signify railway rolling stock, as over there the word "motor" is used to indicate what we call an automobile. North-Eastern Railway (English) diner (1st and 3rd) No. 3753, is a corridor composite carriage, weighing 91,840 lbs. and accommodates 26 persons, i.e., 13 of each class. The dead weight per passenger is therefore 3,532 lbs. This N.E. diner No. 3753 and G.W.R. sleeper No. 9082 have an aggregate weight of 185,472 lbs. and together transport 38 passengers, thus the average dead weight per passenger amounts to 4,880 lbs.

The North-Eastern diner is mounted on two six-wheel trucks and, like all other British corridor cars, has what we would call a vestibule at each end. The body is supported on steel frames, and the lower chord is bent down into the form of a bow-string girder. The windows are wide and high and the absence of a running-board along the side is noticeable. Each of the vestibule doors and the two in the side are provided with short steps, almost on the level of the door sill. The Great Western sleeper has no side doors, the two vestibule doors being provided with short steps.

The British form of composite carriage, by which the different classes of passengers are included in the same vehicle, has the advantage of being more in service in certain sections of the country than if each car carried only one class. Where there is steady and regular traffic the single class car is satisfactory, but where traffic fluctuates or where the "classes" presenting themselves at a station do not always appear in approximately the same proportions, the coach carrying more than one class is likely to have a sufficient number on board to constitute a "paying load," if it can be used at all. Whatever security by form or construction, or whatever safety service may be used, all patrons, regardless of "class," are benefited thereby.

Analyzing what figures are before us, it appears that Canadian and United States day coaches show an average of 1,680 lbs. hauled for each passenger carried, while the British day and corridor carriages show 1,252 lbs. per passenger. The Canadian and United States sleepers show 2,780 lbs. and the British sleeper and diner give 4,880 lbs. The British day coaches have less dead weight than ours, and this is to be expected, as British carriages are proverbially light in construction compared to those on this side. The better showing apparently made by American sleepers is probably due to the fact that the sleeper has here been taken with every section holding four persons. As a matter of fact, this does not occur in practice. If each section only held two persons, the average dead weight would be 5,560 lbs. and, taken day in and day out, this probably approximates to actual performance on many trips. A fairer estimate would seem to be the average of the maximum and minimum figures, or 4,170 lbs. average dead weight per passenger.

The British figure is largely modified by the sleeper and diner, here instanced, being very restricted in accommodation for passengers, and it is probable that the British average is much better. These examples not only show the difficulty of making a fair comparison, but demonstrate again, if that were needed, how unreliable is the inductive method where the evidence to be considered is inadequate. The number of examples available is too small and magazine space too crowded for the results of extended investigation, except in the most condensed form. The point, however, stands out clearly that the question of dead weight in railway rolling stock of all kinds plays an important part in economic operating. There are many and important factors to be taken into consideration, and there is before the student an inviting field for research, which perhaps this presentation of the subject may help. The British and American systems are the result of evolution and it is probable that many things which at first sight appear to be glaring contrasts, may shade down to mere differences of practice, or turn out to be like variations which appear in the same species due to local conditions or to the influence of the habitat.

CORROSION OF NICKEL, CHROMIUM AND NICKEL-CHROMIUM STEELS.

Some corrosion tests are described by J. N. Friend, J. L. Bentley and W. C. West in "Engineering," Vol. 93, p. 753, in which disks were prepared of carbon steels, to serve as standards, of nickel steels, of chromium steels, and of nickel-chromium steels, each 0.7 cm. thick and 2.8 cm. in diameter. These disks were kept nearly immersed in tap-water for 64 days, in sea-water for 60 days, in 0.5 per cent. sulphuric acid for 60 days, in 0.5 per cent. sulphuric acid for 53 days, and they were exposed to alternate wet and dry tests for 52 days. The acceleration tests in 0.5 per cent. sulphuric acid gave misleading results, and the two standard steels which showed practically equal corrosion in all the other tests, showed 100 per cent. deviation with 0.5 per cent. sulphuric acid, and with the other steels there were remarkable differences. In some cases there were indications of galvanic action in the chromium and nickel steels in the acid tests, and no chromium nor nickel passed into solution, showing that these elements were the constituents of the cathode. The resistance of chromium steels to corrosion in salt water suggests the use of this metal for ship-building. Nickel steels show marked resistance both to acid and neutral corrosive solutions, the resistance increasing with increased nickel content.

PROPORTIONING OF CONCRETE.

IN correctly made concrete the amount of sand should be just sufficient to fill the voids in the coarse material, and the amount of cement just sufficient to fill the voids in the mixture of sand and coarse material and to coat all the particles with very thin jointing layers. It is a rational assumption that such concrete will give a maximum of strength with the minimum of cost, and if such assumption be justified by experimental results it follows at once that the proportioning of concrete-forming materials is of the utmost importance. Greater strengths can be obtained by the use of excess of cement, as in the case of the ordinary mix of 1:2:4, but the increase in strength is less than the increase of cost of materials and is, therefore, only justified in particular cases.

The strength of any concrete will depend not only upon the materials and their proportions, but also upon the method of using those materials. Any void in a mass of ¾-in. coarse material may be filled in many ways. Firstly, it may be filled with cement and sand mortar, as in the 1:2:4 concrete; secondly, it may be filled with a piece of stone which practically fills the whole space; and thirdly, it may be filled with a number of stones which vary in size with a minimum amount of cement and sand mortar. The first filling is composed almost wholly of joints, and on that account is weak; the second filling is strong, owing to the absence of joints, but it is impracticable; but the third is a compromise which is not only practicable but also strong. It will be seen that the amount of the variations in size or the grading will depend upon the nature and quality of the work required. On the one hand there will be good but costly filling and on the other a cheap but still good filling, and whether the gradiation be large or small the filling will be better than one of cement and sand mortar only.

With a view to testing the effect of "proportioning" upon the strength and other properties, and also the cost of concrete, John A. Davenport and Prof. S. W. Perrott, of the civil engineering department of Liverpool University, drew up a series of experiments, the intention being to test compressive strength, modulus of rupture, specific gravity, water resistance, and fire resistance. Various difficulties arose in the course of the work which prevented the inclusion of specific gravity, water resistance and fire resistance tests. The results were contained in a paper recently presented by them at a meeting of The Concrete Institute, and entitled "Sand and Coarse Material and Proportioning Concrete."

The series involve 216 test pieces, to which must be added others prepared for water and fire resistance and specific gravity tests, but which could not be tested in the time available. The voids were measured in a patent apparatus designed by Mr. Davenport, which gives results to 1/5 of 1%; and which was found to be independent of the observer. The preliminary data comprised tests on Portland cement, size of granite chips, volume of chips per batch, percentage volume of voids in chips, sizes of river-sand used, volume of sand used per batch, percentage volume of voids in sand, and the volume of cement used per batch. Regarding the latter item it must be noted that no allowance was made for the excess cement required for jointing, only the amount required to fill the voids being used. Had time permitted it, the correct allowance in each case would have been ascertained and additional tests made therewith. The limited time made it impossible to test the cement before using it for the concrete testpieces, the brand only suggesting its probable good qualities.

The batches were hand-mixed by engineering students and as no special means of testing the thoroughness of the mix were adopted, the resulting concrete will probably not compare favorably with machine-mixed concrete so far as uniformity of results go. Every care was exercised, however, in mixing to get all the materials thoroughly intermixed and apparently uniform. This proved to be the case when the specimens were tested. The moulds were made of planed boards, bolted together with gangs, damped before using, and lined with paper on the under side to facilitate removal. In spite of this, several pieces were damaged in removal, due more particularly to the relatively small sections used.

Immediately after mixing, the moulds were filled and left in a tool shed till required for testing. They were wetted regularly every three or four days.

It was found that the ratio of compressive to tensile strength varied more in the one-month than in the three-month tests, and is not sufficiently uniform to base any conclusions upon, beyond the fact that such ratio is not constant. It is considered by the authors, however, that this ratio should be more or less constant as the failure, whether compressive or tensile, depends upon the adhesive strength of the cement.

The ratios of strength at three months to strength at one month were more or less uniform, more particularly in the case of comparative strengths. In the case of 1:2:4 concrete the modulus of rupture appears to increase more rapidly than the compressive strength, while in the other series with cement accurately proportioned, the compressive strength increases more rapidly than the modulus of rupture, as out of six series only one runs the other way, probably due to rather dry mixing of those three-month test pieces.

Although the cement tests are unsatisfactory, it will be possible to compare the strengths and costs of the concrete in the different series, as they will probably all be affected to the same extent. The most important point brought out by such comparison is the fact that for accurate proportions, the ratio of cost of cement to total cost is practically constant for all gradings taken in the tests, so that when the graded coarse material is used the total cost need only be further considered. Of course, the total cost is always the final criterion as regards economy, and it may be suggested that the ratio cost of cement to total cost need not be considered. But the relative values of total cost obtained may be altered when additional tests are made at other ages, and it is difficult to say whether they will be affected by the ratio, so that if it can be shown conclusively that this ratio is constant or nearly so, the total cost, age and proportions need only be dealt with.

The authors did not feel justified in attempting to generalize from the results which they obtained, as they considered such results did no more than open up the subject of proportioning and grading in relation to cost. They had no hesitation, however, in saying that the figures given by them show conclusively that the subject is well worth being made the object of special research.

It is announced at Ghent, Belgium, that the third section of the railway line of the Great Lakes will, it is estimated, be completed as far as the shore of Lake Tanganyika, during the second half of the current year as only 50 kilometers of rails remain to be placed and several bridges to be completed.

PROTECTION OF STEEL GIRDERS FROM SMOKE.

The problem of protecting steel work from locomotive smoke has been coped with by the city of Baltimore in an unusual but, up to the present, satisfactory manner. The city engineer, Mr. H. K. McCay, gives a brief description in "Municipal Engineering" of the method followed to protect the steel viaducts directly over railroad tracks throughout the city from the detrimental influence of the gases and cinders from locomotives.

The city of Baltimore is divided by a stream of water which flows from the northwest to the southeast through the most populated districts of this city. The various railroads have utilized the valley of this stream for the purpose of ingress to and egress from the city, laying their tracks along and parallel therewith. Union station, used by the Pennsylvania, Western Maryland and Northern Central railroads, is practically on the banks of this stream. In order to carry the north and south streets in Baltimore across this stream and across the railroad tracks it was necessary to construct at a great deal of expense, five bridges, namely: Guilford avenue, Calvert, St. Paul and Charles streets, and Maryland avenue. Most of these bridges span the railroad tracks at a height which prevents the gas from the engines destroying the steel, but on two bridges, namely, the Calvert and St. Paul street, the clearance is such that the blasts from the engines destroy any protection that is put over the lower members to protect them.

The Calvert street bridge is a magnificent structure, 62 feet in width, with a total length of about 600 feet. The spans are the bow spring type of truss, and made almost entirely of wrought iron. This bridge was built in the year 1878, and cost approximately $220,000. There is a clear span over the railroad tracks of about 146 feet, and a clearance over the Pennsylvania tracks of 23 feet. The author found, as stated above, that the lower members of this bridge became badly corroded from the gases of the locomotives, as many as five hundred of these engines passing under this bridge each day. It had been the practice of the city engineer's department to paint these bridges each year, either with coal tar paint or with the very best red lead paint obtainable. He also found it was nearly impossible to use the ordinary scaffolding to allow time for the paint to harden, therefore he constructed a closed scaffolding, and swung the same beneath the bridge, cleaned off the lower members very carefully and repainted with two coats of paint, allowing the scaffolding to remain as a protection for a week or ten days until the paint thoroughly hardened. In spite of all this protection, it was found that the paint would not stand the blast from the engines, and the lower members, in order to preserve them, had to be painted each year.

Mr. McCay therefore decided to encase the lower members of the bridge in concrete, and careful computation was made as to whether the weight of the concrete would alter the stresses and strains as calculated for this bridge. He found, by removing some ornamental castings, which were of no vital moment to the bridge, that a comparatively thin coat of concrete could be placed on the bridge without increasing the stress or strain, and, if anything, improve the stability of the lower members, thereby reducing to some extent the vibration.

The lower members of the north span consist of nine built-up steel girders, with a surface area of approximately 5,000 square feet. The specifications called for concrete to be put over these members to a thickness of 1½ inches. These girders were carefully cleaned by means of sand blasting and acids, so that all of the old paint was removed, and the steel surface carefully exposed. Wire mesh reinforcement was carried all around the beams, and a coat of "gunite," 1½ inches in thickness, was applied; the gunite following the contour of these beams. The reinforcement is held away from the face of the steel by means of ½-inch iron rods, as it was found that the channel method was not satisfactory.

The total area, as mentioned above, was about 5,000 square feet for the north span of this bridge, and the contract was let at $1.25 per square foot. An additional area has recently been advertised and the contract let at an expense of 95 cents per square foot.

The grout placed by means of the cement gun proved very dense and thick and there is absolutely no danger of gases from the engines penetrating the steel through this grout and Mr. McCay is of the belief that the city of Baltimore has gotten rid of a very expensive renewal item by the adoption of this method.

NITRITE TEST FOR POLLUTION.

In a paper which he read at the recent convention in Philadelphia of the American Water Works Association, Mr. W. M. Booth outlined his use of the nitrite test in tracing a source of pollution in a supply of drinking water, and endeavored to show from experimental results the relation between the nitrites and the existence of the source of probable pollution in a number of cases of springs, wells, streams and lakes. In the instance in question, the author, who has for some time made accasional analyses of a certain water supply at a matter of record, found the nitrites unusually high, accompanied by high ammonias and colonies of bacteria on gelatine. A simple drive well was driven about 8 feet into the ground at numerous points around the wells from which the supply was drawn, and tests for nitrite made on the water pumped from these. By noting which wells showed the highest nitrite, he was able to locate a large amount of decomposing animal matter. The nitrite in the waters from the several wells varied from nothing and .002 to as high as .046 and .044, the latter being found near the putrifying matter referred to.

TIMBERS PRESERVED IN SALT.

In replacing a trestle recently burned along the north shore of Great Salt Lake, according to the "Railway Age-Gazette" engineers found piles perfectly sound after 43 years of service. At another point on the lake, piles 18 in. thick, set 20 years ago, are similarly preserved with salt which has penetrated to their very centre. Timbers in trestles across Salt Lake, placed in 1902, appear to be as good as when they were driven. They have been preserved well above water line by the salt dashed on them by the waves. The first transcontinental telegraph line was abandoned when the railroad was built, and the old poles were sawed off at the ground. An engineer who recently examined the butts in the salt desert near Fish Springs found that, although fifty years had passed since the poles were cut off, the old butts were perfectly sound.

Telephone companies in the Salt Lake valley use salt for preserving poles. When set up, about a bushel of salt is placed around the pole on the ground. The reason why the waters of Salt Lake act as a strong preservative, as distinguished from ocean waters, is because the lake water contains so much more salt, being practically a saturated solution.

MODERN BITUMINOUS SURFACES AND BITUMINOUS PAVEMENTS.*

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ALTHOUGH bituminous pavements have been in use in American municipalities for nearly fifty years, the introduction of modern bituminous surfaces and bituminous pavements in the construction of highways outside of built-up districts is of comparatively recent origin in America, dating from about 1906. This point is well illustrated by the fact that in 1908 the total yardage of bituminous surfaces and bituminous pavements constructed under the jurisdiction of the eight leading state highway departments in the eastern part of the United States was only 416,700. Since that period the growth of the use of bituminous materials in the construction and maintenance of roads and pavements has been exceedingly rapid.

In order to avoid misunderstandings, the various methods of using bituminous materials referred to in this paper will be explained by the following definitions:—

Bituminous surfaces are those consisting of superficial coats of bituminous materials with or without the addition of stone or slag chips, gravel, sand or materials of a similar character.

Bituminous macadam pavements are those consisting of broken stone and bituminous materials incorporated together by penetration methods.

Bituminous gravel pavements are those consisting of gravel and bituminous materials incorporated together by penetration methods.

Bituminous concrete pavements are those having a wearing surface composed of stone, gravel, sand, etc., or combinations thereof, and bituminous materials incorporated together by mixing methods.

The definitions of bituminous surfaces and bituminous concrete pavements quoted above have been advocated for adoption in the reports of the special committee on "Bituminous Materials for Road Construction and Standards for Their Test and Use" of the American Society of Civil Engineers, whereas the fundamentals of the above definition of bituminous macadam pavements are embodied in the following quotation from the 1913 report of the association for standardizing paving specifications: "If the stone is spread in place and the bituminous cement or binder applied afterwards, the resulting product is bituminous macadam." As sheet asphalt pavements have been in use for many years and as the essentials of good construction have been well established, this type of bituminous pavement will not be dealt with in this paper.

Bituminous Surfaces—Since the formulation of the fundamental principles of the successful construction of tar surfaces by the engineers of the Department of Roads and Bridges of France in 1903, bituminous surfaces have been used extensively in Europe. As an illustration, might be cited the construction of five million square yards of tar surfaces in one county of England, in 1911, under the supervision of the county surveyor of Kent, H. P. Maybury, M.Inst.C.E. During the past eight years American engineers have used bituminous materials in this method of construction and maintenance of roads and pavements.

In the case of broken stone and gravel roads, the most efficient method of procedure is to thoroughly clean the surface by sweeping with hand brooms or horse sweepers and hand brooms, the final sweeping being done with bass or other fine fibre brooms. The bituminous material, which is generally heated, is applied to the surface in amounts varying from one-quarter to one-half gallon per square yard with the aid of pouring cans, hose attached to tanks, hand-drawn gravity distributors, horse-drawn or motor truck gravity or pressure distributors. Some kind of mineral coating is generally applied to cover the bituminous material. The degree of cleanliness of the surface obtained by sweeping will depend to a large extent upon the details of the original construction. It has been found that a road with a thoroughly rolled and well puddled broken stone wearing surface composed of road metal from one inch to two and one-half inches in longest dimension may be easily cleaned and the essential adhesion of the bituminous surface readily secured. This method is characteristic of the modern practice of many of the foremost English and French engineers.

Considerable development has taken place in the use of different kinds of bituminous materials. Tars, both of the water-gas and coal-gas types, continue to be used to a large extent. Without doubt the most comprehensive specifications for the construction of bituminous surfaces with tar are those adopted by the Road Board of England. There has been noted a growing objection to the use of certain asphaltic oils which require from two to three weeks to "set up" to such an extent that tracking will not occur.

Bituminous Macadam and Bituminous Gravel Pavements.—Bituminous macadam and bituminous gravel pavements are of many types, one of the primary differences in construction being the use of one or two applications of the bituminous material. The efficacy of many of the types depends upon the combinations of sizes of broken stone or gravel and the combinations of bituminous materials used when two applications are employed. Variations in types also exist dependent upon the manner in which the different courses may be filled and the treatment of the filled course prior to the application of the bituminous material. The one-application method is very similar in its simplest form to the construction of a bituminous surface except that the bituminous material is applied upon a much more open surface. In the case of the two-application method in certain instances an attempt is made to build up a two-course pavement, while in others the second application is in reality used as a seal coat.

Two of the main difficulties in the construction of bituminous macadam pavements have been to secure a thoroughly compacted wearing course of non-segregated broken stone and the uniform application of the bituminous cement so that the broken stones of the wearing surface would be uniformly bound together. In connection with the above statement should be noted the following excerpt from the 1914 report of the special committee of the American Society of Civil Engineers:—

"An important factor for successful results (in the construction of bituminous pavements by the penetration method) is the thorough compaction by rolling of the road metal before the spreading of the bituminous material."

Two methods which have given satisfactory results will be cited as examples of modern practice.

When the metalling in the wearing course consists of a naturally graded aggregate ranging in sizes from one-half inch to an inch and one-quarter, it has been found unnecessary to further fill the voids by the application of a finer product before the first application of the bitu-

*Presented before the Canadian and International Good Roads Congress at Montreal, on May 20, 1914.

minous material. The character of the product referred to above is shown by the following mechanical analysis:

Percentage passing	½ inch screen	18.9
" "	¾ " "	43.1
" "	1 " "	34.4
" "	1¼ " "	3.6
		100.0

After the wearing course has been thoroughly rolled, from one and one-quarter to one and three-quarters gallons to the square yard of bituminous material is uniformly distributed. Stone chips, free from dust, are then distributed to fill the surface voids. After the chips are rolled a seal coat of one-half to one gallon per square yard of bituminous material is applied. The pavement is finished by the rolling of a second application of stone chips.

As the second method, will be described what the writer considers the most satisfactory type of bituminous macadam pavement at present constructed in England. The bituminous pavement referred to is known by the name of "Pitchmac," and was designed by the city engineer of Liverpool, John A. Brodie, M.Inst.C.E. The following description of the standard method employed in Liverpool is given by Mr. Brodie:

"Pitch grouted macadam has been found to give most satisfactory results in streets of medium and light traffic, and is now being largely used in place of ordinary macadam, and also of more expensive pavements. It is laid to a depth of from 3½ inches to 4½ inches, in two layers. Welsh granite macadam is used, broken to a 2½ inch gauge for the lower layer and to 1½ inch for the top surface. Each layer is put down dry and continually rolled before and after the grouting of pitch and sand mixture has been applied, until the surface is thoroughly consolidated. The foundation is generally of hand-pitched rock, 10 inches deep as for ordinary macadam, but in some cases a bed of 6-inch concrete has been used on main roads. Pitch macadam is also being much used as a surface covering for old boulder pavements, many of which still exist in Liverpool in old streets where the traffic is very small. The cost of pitch macadam may be [illegible] 2¼ cents per square yard per inch of depth."

Bituminous Concrete Pavements.—Bituminous concrete pavements other than sheet asphalt and pavements laid by companies as proprietary articles have received more attention during the past three years than at any time since the days of Abbot, Leverich, Scrimshaw and Van Camp. Less fear of litigation proceedings and the introduction of economical mixing machines equipped with heating attachments have exerted a marked influence. But, furthermore, the rapidly growing recognition of the inherent advantages of bituminous pavements constructed by the mixing method has been largely instrumental in its adoption for traffic conditions for which it is believed to be economical and suitable. Bituminous concrete pavements in which broken stone forms an integral part of the mineral aggregate, may be divided into three classes.

It is self-evident that the simplest type is one having a mineral aggregate composed of one product of a crusher, that is, similar to the product, in the usual type of portable crushing and screening plant, which passes over one screen and through the larger holes of the adjacent screen. This broken stone, in certain cases, may be somewhat uniform in size, but usually such is not the case. In the writer's opinion, an essential element in the construction of this type of bituminous concrete pavement consists in using a product of a crusher which will have a range from an inch to an inch and a quarter in its size. As an illustration will be cited a mechanical analysis of a product which was obtained from a plant where the broken stone passed over a one-half inch screen and through a one and one-quarter inch screen.

Percentage passing	⅛ inch screen	1.2
" "	¼ " "	4.2
" "	½ " "	34.7
" "	¾ " "	40.6
" "	1 " "	17.3
" "	1¼ " "	2.0
		100.0

It is apparent that the above product would not be referred to as composed of uniformly sized stone. It is of interest to note that certain bituminous concrete pavements, having a width of twenty-five feet, constructed with this product of broken stone in 1911 have been subjected to an average daily mixed traffic of two thousand to three thousand vehicles and are at present in excellent condition with no maintenance charges to date.

This type of bituminous concrete pavement has been constructed for many years by using either one or, in certain cases, several courses of broken stone mixed with bituminous cement. As an illustration of the latter method will be cited the practice of one large construction company which builds this type of pavement. The first, or bottom course, of metal coated with bituminous cement ranges from one and one-quarter inches to two and one-half inches; the second course, from one-half inch to one and one-quarter inches; and the third course, from one-quarter inch to one-half inch. The pavement is finished with a dressing of uncoated chips.

Asphalts, tars and tar-asphalt compounds have been used for the bituminous cement. In some cases one kind of bituminous material has been used in the mix and another kind for the seal coat; one of the most common combinations being the use of tar in the mix and asphalt for the seal coat.

As illustrative of some of the details of construction of this type of bituminous concrete pavement which should be covered in contracts, excerpts from specifications recently drafted by Mr. Prevost Hubbard and the writer for the New York Department of Efficiency and Economy will be cited. It should be borne in mind that the temperatures and other limitations specified apply to the bituminous cements and mineral aggregate covered in other sections of the specifications.

"Broken stone for the bituminous concrete shall be heated, as directed, before entering the mixer, to between 66°C. (150°F.) and 149°C. (300°F.) in revolving dryers in which no flame shall be permitted to come in contact with the broken stone and in which the broken stone shall be continuously agitated during the heating.

"The asphalt cement or refined tar shall be heated in kettles so designed as to admit of even heating of the entire mass, with an efficient and positive control of the heat at all times. Asphalt cement shall be heated as directed to a temperature between 135°C. (275°F.) and 177°C. (350°F.). All asphalt cement heated beyond 177°C. (350°F.), either before or during mixing with the broken stone, shall be rejected. Refined tar shall be heated as directed to a temperature between 93°C. (200°F.) and 135°C. (275°F.). All tar heated beyond 135°C. (275°F.), either before or during mixing with the broken stone, shall be rejected.

"When thoroughly heated to the temperature directed, the asphalt cement or refined tar and the broken stone for the bituminous concrete shall be mixed so that the resulting mixture shall contain between five (5) and seven and one-half (7½) per cent. by weight of bitumen as directed. A mixer shall be used, having revolving blades, and so designed and operated as to produce and discharge a thoroughly coated and uniform mixture of nonsegregated broken stone

and asphalt cement. When discharged, mixtures of asphalt cement and broken stone shall have a temperature not more than 149°C. (300°F.), and not less than 93°C. (200°F.), as directed. When discharged, mixtures of refined tar and broken stone shall have a temperature not more than 121°C. (250°F.), and not less than 66°C. (150°F.), as directed.

"The bituminous concrete, heated and prepared as specified, shall be delivered direct from the mixer to the point of deposition on the foundation in trucks or wagons, provided with canvas covers for retaining the heat. As delivered the bituminous concrete shall have a temperature of at least 66°C. (150°F.). Material having a lower temperature than this shall not be laid upon the foundation.

"Rollers used on the bituminous concrete and the seal coat shall be well balanced, self-propelled, tandem rollers, weighing between ten (10) and twelve (12) tons each. Each shall have a compression under the rear roller of between two hundred (200) and three hundred and fifty (350) pounds per linear inch of roll, and shall be provided with an ash pan, which shall prevent ashes dropping onto the bituminous concrete or seal coat.

"As soon as possible after the compaction of the bituminous concrete, when the surface is clean and dry, a seal coat of the hot asphalt cement shall be evenly distributed over the bituminous concrete and spread by means of squeegees as directed. The asphalt cement shall be applied at a temperature not less than 135°C. (275°F.), nor more than 177°C. (350°F.), at a rate of one-half (½) to one (1) gallon per square yard, as directed. A thin, uniform layer of dry, clean, No. 1 broken stone (stone chips) shall be immmdiately spread over the asphalt cement, as directed, by machines or skilled workmen. The spreading of the No. 1 broken stone shall not lag more than twenty (20) feet behind the placing of the asphalt cement coating. Number 1 broken stone shall not be placed on the wearing course before the asphalt cement of the seal coat is applied. The surface of the bituminous concrete shall be kept scrupulously clean until the seat coat is applied, and the contractor shall not permit any hauling over the wearing course before the completion of the seal coat.

"No bituminous concrete shall be mixed or placed between October 1 and May 15, except by written permission, and no bituminous concrete shall be mixed or placed when the air temperature in the shade is below 10°C. (50°F.), or when the foundation is damp or otherwise unsatisfactory."

The second type usually consists of the broken stone composing one product of a crusher and sand or other fine mineral matter mixed together with a bituminous cement. The wearing surface of this mix is sometimes finished by rolling in fine stone chips but generally a seal coat is used together with fine mineral matter for a top dressing. When constructed on a commercial scale, the mineral aggregate is always heated and mixed in a specially constructed machine. Usually the same grade and type of bituminous material is used for the mix and the seal coat.

In the third type of bituminous concrete pavement the composition of the mineral aggregate is definitely covered in properly drawn specifications. As an example may be cited the following method of covering the composition of the mineral aggregate of Warrenite, a proprietary pavement of the Warren Brothers Company, which was used by William H. Connell, chief of the Bureau of Highways, in drafting specifications for the City of Philadelphia.

"Material passing 1¼-inch screen and retained on No. 2 sieve, 40 to 60 per cent. Material passing No. 2 sieve and retained on No. 4 sieve, 10 to 20 per cent. Material passing No. 4 sieve and retained on No. 10 sieve, 10 to 5 per cent. Material passing No. 10 sieve and retained on No. 30 sieve, 10 to 5 per cent. Material passing No. 80 sieve at least 25 per cent.. of which will pass a No. 200 sieve, 10 to 5 per cent. The balance, to pass No. 30 sieve and be retained on No. 80 sieve."

The 1914 specifications of the State of New Jersey contain the following description of the grading of a bituminous concrete pavement similar to the one given above.

Size of Screen.	Percentages, Minimum.	Maximum.
Passing 1½" and retained on 1"	0	15
Passing 1", retained on ½"	40	50
Passing ½" and retained on ¼"	10	25
Passing ¼" and retained on a 10-mesh sieve.	8	15
Passing 10 and retained on a 30-mesh sieve.	12	22
Passing 30 and retained on a 80-mesh sieve.	5	15
Passing 80 and retained on a 200-mesh sieve.	3	8
Passing a 200-mesh sieve	2	8
Bitumen content	6.5	8.5

As another illustration might be cited the well-known Topeka specification, which covers a definite grading of a mixture of broken stone and sand. The Topeka grading is as follows:

Percentage of bitumen ....from 7 to 11
Percentage of mineral aggregate passing 200 mesh screen ....from 5 to 11
Percentage of mineral aggregate passing 40 mesh screen ....from 18 to 30
Percentage of mineral aggregate passing 10 mesh screen ....from 25 to 55
Percentage of mineral aggregate passing 4 mesh screen ....from 8 to 22
Percentage of mineral aggregate passing 2 mesh screen ....less than 10

In the construction of all types of bituminous concrete pavements, in addition to the requirements covering the properties of the bituminous cement and the quality and character of the mineral aggregate, certain essential features should be given careful consideration. The following citations from the 1914 report of the special committee of the American Society of Civil Engineers are specially pertinent:

"Where the character of the traffic justifies the use of a bituminous concrete pavement, the same conditions demand an extraordinarily strong foundation therefor.

"The amount of bituminous material to be used in any case will depend upon the peculiar conditions of that case, such as the kind of road metal and of bituminous material, the character of the aggregate, the climatic conditions, etc.

"The character of the mineral aggregate to be used may be controlled by local conditions, but the best results can only be obtained by the use of the best materials. Excessive sizes or excessive variations in the size of the mineral particles, should be avoided, and the utmost care must be taken to avoid the segregation of the different size particles.

"Mixing machines should be used, and hand-mixing methods should be avoided wherever practicable.

"In the use of a heated aggregate for the construction of a bituminous concrete pavement, non-uniformity or excess in the heating of stone should be avoided.

"Where bituminous pavements are laid, the edges should be protected and a sudden transition from the pavement to any softer shoulder material avoided by means of cement, concrete or other edgings and such reinforcement of the shoulder material as may be necessary."

DIAGRAM OF CONCRETE MATERIALS.

In *The Canadian Engineer* of May 21st, 1914, there appeared a diagram for obtaining quantities of materials required per cubic yard of concrete. This diagram was prepared by R. O. Wynne-Roberts, Consulting Engineer, Regina. A number of extra copies of this diagram have been printed and mounted on stiff board. They should be found of value in estimating quantities and costs. Some may desire to have a copy, mounted as above, on hand for easy reference, thus obviating the necessity of removing a page from the issue in which it was published. Upon receipt of 10 cents to defray postage expense, one of these will be mailed to any address.

DEATH RATE OF WATER BACTERIA.

INFORMATION pertaining to the destruction of bacteria in drinking water and in polluted rivers and streams has come to be regarded as being an important necessity in every community. This, largely for the reason that the knowledge of the danger of pathogenic bacteria to the health of water-users has become widespread.

There enters into the investigation of the degree of pollution and the danger resulting therefrom, the question of the longevity of B. coli. This is necessary in determin-

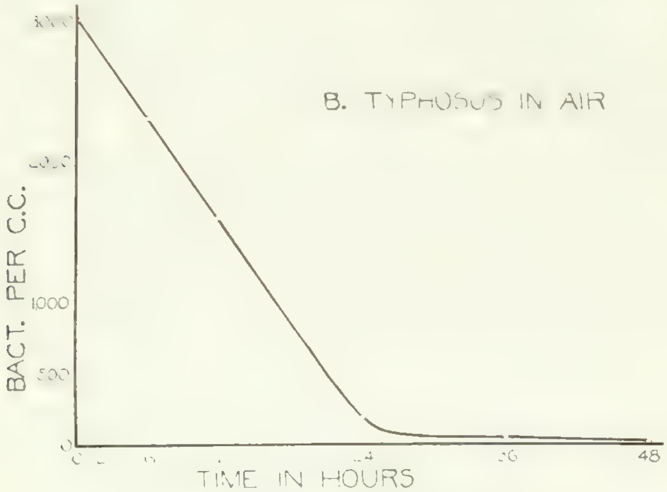


Fig. 1.—Death of B. Typhosus in Air.

ing the length of time a sample of water may be kept prior to analysis. It is also useful in a determination of the volume to be used in such analysis.

In a paper recently prepared by Dr. Otto Rahn, assistant professor of bacteriology, University of Illinois, and Mr. M. E. Hinds, assistant chemist of Illinois State Water Survey, the results are given of experiments made to determine the rate, manner and factors influencing the death of bacteria in drinking water and polluted streams. This paper was presented at a meeting of the Illinois Water Supply Association. From it the following information is secured:

As a number of uncertain factors would be involved in working with a natural water or sewage, it was thought

Table I.—Theoretical Number of Cells Present at End of 60 Hours and for Each 6-Hour Interval.

Hours.	Theoretical number of cells.	Actual number of cells.
0	1,000,000	315,000
6	100,000	40,000
12	10,000	937
18	1,000	—
24	100	Less than 1
30	10	
36	1	
42	.1	
48	.01	
54	.001	
60	.0001	

best to work first on pure water under known conditions and to vary the conditions until they finally approached those found in natural waters. The water used for this work was ammonia free, which, however, contained a very small amount of nitrogen. It is purer than ordinary distilled water, being redistilled twice, and is the purest grade of water obtainable unless a large amount of labor is spent on its preparation.

The rate of death of B. typhosus as found by different observers is variable, probably due to different experimental conditions. Of the many contradictory statements concerning the death rate, it is difficult to determine which one is correct as most of the data appear to be reliable. This leaves us in doubt as to whether death is due to lack of food, presence or absence of oxygen, temperature changes or antagonism of other bacteria.

During the last seven years we have learned that bacteria under unfavorable conditions die gradually. Of the total number, a certain percentage will die in a unit of time and of the number surviving the same percentage will die in the next unit of time. As far as we know, this law holds true with all causes of death, whether by disinfectants, light, drying or heat. We know of no exception.

It was only natural to expect this same regularity of death to hold true in the case of B. typhosus and B. coli in pure water. The experiments showed this to be the case. The reduction in the case of B. typhosus was 89.3 per cent. in six hours, that is, after six hours' time only about 10 per cent. of the original number survived. Assuming 1,000,000 cells to be present in the beginning, we find the numbers remaining as shown in Table I., which is based on a reduction of 90 per cent. in each six-hour period.

It is easily seen that we never come to an absolute zero. There are always some bacteria left alive, but the number soon becomes so small, that for practical purposes, we might consider them absent. Table I. shows a reduction in 60 hours from 1,000,000 per c.c. to less than 1 per gallon. Whether such water would be considered safe for use, is questionable. In 96 hours, we would have less than one typhoid bacterium per 1,000,000 gals. Such water would probably be safe. Certainly, no bacteriological or other analysis could discover the bacterium.

B. coli does not die quite as fast as B. typhosus, about 72 hours being necessary to reduce their number from 1,000,000 per c.c. to 1 per gal. Kruse states that B. coli is found a normal inhabitant of all waters, whether good or bad. We can find it, if we only take a large enough sample.

Knowing the facts, we tried to find the cause of death. It is probable that the death of B. coli and B. typhosus in pure water is due to starvation. A sample of tap water was sterilized and inoculated with B. coli and proved to be a fair medium for growth. An initial number of 1,500,000 increased slowly to 3,000,000 in twelve days and then slowly decreased, over half the original number being still present at the end of five weeks, when the experiment was discontinued. At the same time a sample of deep well water with a very high mineral residue was sterilized and inoculated with about 2,000,000 B. coli per c.c. and only 1 per c.c. was found at the end of two days. This death rate was higher than in very pure water. Only a trace of organic nitrogen was present.

It is very important from a practical viewpoint to decide whether or not dissolved oxygen plays any part in the rate of the death of bacteria in water. Whipple and Mayer found B. typhosus died about 20 times as fast without oxygen as with it, and B. coli died about twice as fast. The absence of oxygen was secured by keeping the tubes in an atmosphere of nitrogen and hydrogen. This would suggest a suffocation of bacteria. In our work we have been unable to get the same results with B. coli, as in all of our tests the death rate was lower with-

out oxygen. Our work on B. typhosus bears out the previous work in that the death rate is higher in nitrogen than in air, but the difference is slight as compared with Whipple's, perhaps due to a different strain, perhaps to different water. Figure 2 shows the difference in death rate in air, hydrogen and nitrogen.

The temperature of the water has a direct bearing on the death rate. Even though B. coli and B. typhosus both grow much better at 37° C. than at 20° C., when cultivated under growing conditions, they also die faster at the higher temperature. With B. coli we have found the rate of death to increase 1.8 times with each 10° rise in temperature. Growth and death of bacteria must be looked upon as chemical reactions, and, therefore, must proceed faster at higher temperature within certain limits. In work with B. typhosus in Lake Michigan water, Russell found the death rate increased eight times from freezing to 12° C.

In 1911 Ruediger determined the rate of death of B. coli and B. typhosus in river water under natural conditions both in summer and in winter. He attributes the

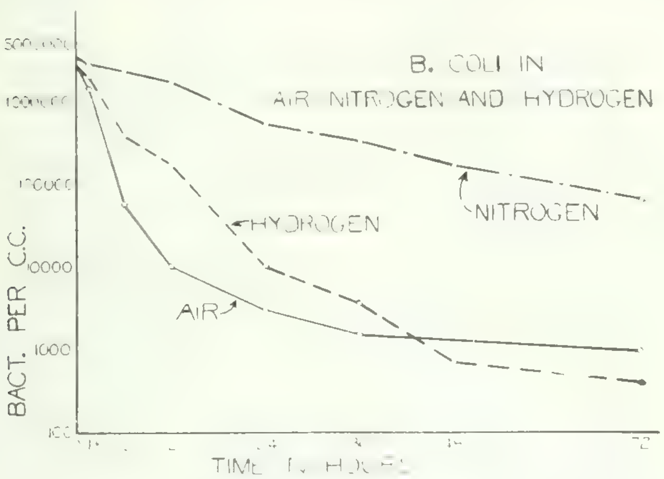


Fig. 2.—Death of B. Coli in Air, Nitrogen and Hydrogen.

faster death rate in summer to the effect of light and to saprophitic plants. We can account for the change in death rate as a change due to the difference in temperature.

Conclusions.—In pure, natural water and in redistilled water, B. coli and B. typhosus die from starvation in the gradual, regular manner observed with other causes of death.

The rate of death increases with the temperature.

The presence of oxygen under these conditions, seems to be harmful for B. coli, but beneficial to B. typhosus.

Further work is to be done on the effect of organic matter, mineral matter, other organisms and the temperature coefficient under these varying conditions.

A NEW STADIA CIRCLE.

THE subsequent computations necessary to reduce observed stadia distances to the correct horizontal and vertical distances have long been a source of trouble and labor to the surveyor. Many arrangements, such as charts, tables, and slide-rules, have been devised to minimize this work, but all have been somewhat complicated and have presented a fruitful source of error. For this reason stadia measurements have not found the universal application which their accuracy and convenience would presuppose.

In the new K. and E. stadia circle an arrangement is presented which will undoubtedly stimulate the use of stadia measurements in all branches of surveying. Not only does this arrangement facilitate the taking of field notes, but it reduces the calculations of these notes to simple arithmetical processes, and, furthermore, the arrangement does not encumber the instrument with complicated and delicate equipment.

The usual method of taking stadia measurements is to observe the interval intercepted on a rod by the stadia hairs and the angle of depression or elevation of the telescope. With this data the observer is then enabled, by using the formulas $H = S \cos.^2 a$, and $V = \frac{S}{2} \sin. 2\,a$, to compute the correct horizontal distance and elevation of the point in question. The mechanical means devised for the solution of these formulas have greatly simplified the plotting of notes, but their use still involves considerable labor and necessitates the carrying of extra equipment into the field.

This new stadia circle is a modification of the regular transit circle, whereby the degree graduations on two opposite segments are replaced by special graduations which give directly the per cent. of the observed stadia distance represented by the horizontal and vertical components.

Through an arc of approximately 60° at the right and left-hand sides of the circle the degree graduations are replaced by the special stadia graduations. At the index marked "Hor." is read the percentage factor to be applied to the observed stadia distance to obtain the correct horizontal distance. At the index marked "Vert." is read the percentage factor to be applied to the observed stadia distance to obtain the difference in elevation between the rod and instrument. Complication in the calculations is avoided by bringing the centre cross hair of the telescope to target or mark on the rod, which has been placed at instrument height before reading H. and V.

Example.—Suppose the observed stadia distance to be 480 feet and the telescope, when sighted on target, to be inclined at such an angle that the reading at the Hor. index is .97 and at the Vert. index .17. Then the correct horizontal distance would be 480 x .97 = 465.6 ft., and the difference in elevation would be 480 x .17 = 81.6 ft.

The simplicity of this arrangement would seem to raise doubts as to its accuracy, but the position of each special graduation is theoretically correct, and exhaustive tests of the instrument throughout the full range of the stadia graduations have proved the device to be practically free from error.

Over a long series of tests by different observers the average error in the reading of the horizontal correction factor was found to be 0.05, which in a 500 ft. sight would introduce an error of 0.25 ft. in the computed horizontal distance. The same trials applied in the reading of the vertical correction factor disclosed an average error of 0.02, which in a 500-ft. sight would introduce an error of 0.10 ft.

By the method of least squares the average error in reading was computed to be: Horizontal + or — 0.09; Vertical + or — 0.07. These larger errors, in a 500 ft. sight would affect the computation of the horizontal and vertical distances by + or — 0.45 and + or — 0.35 ft., respectively, and as the allowable error in stadia work is 1 per cent., it will be readily seen that, in accuracy, this stadia circle compares favorably with any method of computation now used.

USE OF LIQUID CHLORINE AT PHILADELPHIA AND OTHER PLACES.

THE Torresdale intake of the Philadelphia waterworks is in the Delaware River, about 12 miles above the business centre of the city. A review of the results obtained by the filter plant, which has now been in operation at Torresdale for nearly seven years, was given in a paper read by Francis D. West, chemist in charge of the Torresdale Laboratory, and J. S. V. Siddons, superintendent of the filters, before the New England Waterworks Association at its annual convention in September last. The paper contained a general summary of the results obtained with the use of calcium hypoat hand, viz., the results obtained with liquid chlorine, the following information respecting the former process is given:

Bleach was first used at Torresdale in the form of hypochlorite of soda produced electrolytically, during September, 1909. Two cells manufactured by the National Laundry Company were used. A current of 35 amperes at 110 volts was used to decompose a brine solution. The temperature of the bleach solution averaged 110 deg. F. The chlorine and the soda were allowed to recombine, and the temperature was so high that chlorates were formed.

The bleach was applied directly in front of the inlet valve of one of the pre-filters operated at a 20-million-gallon rate, or one-fourth normal. The conclusions were, in part, that the bacterial efficiency of the filter was considerably less than that of filters operated at four times the rate without treatment.

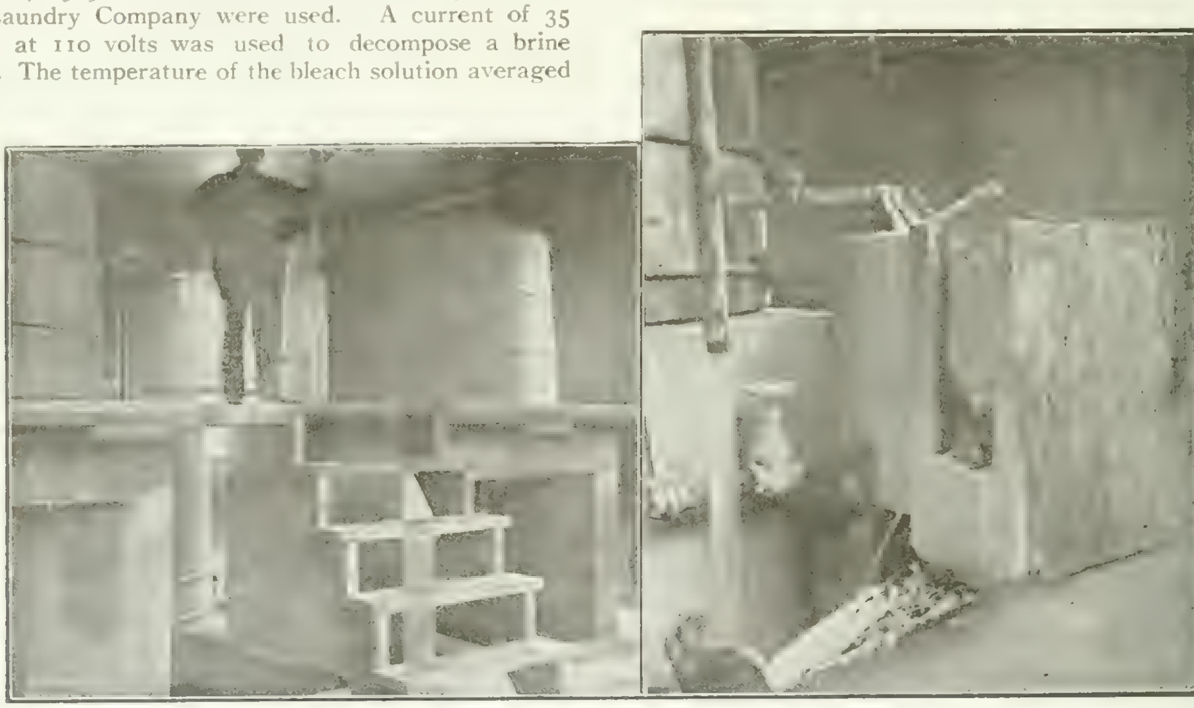
Hypochlorite was again used in December, 1910. Due to the fact that the bacterial efficiency of slow sand filters decreases materially in cold weather, and the fœcal organism, B. coli communis, was present in the filtered water, it was decided to use chloride of lime to disinfect the water in the filtered water basin. Treatment was continued until April, 1911, and stopped until December, when it was again started and used without interruption until February, 1913.

The bleach plant at first consisted of two cedar mixing tanks about 5 ft. in diameter and 4 ft. deep, and one solution tank of the same dimensions, together with a yellow pine orifice tank 2 ft. to a side, which was soon changed to a concrete tank of the same dimensions. After five months' continual service the tanks became so badly perforated that they could no longer be used and were replaced by new tanks lined with 3 in. of concrete.

Fig. 1 shows the mixing and solution tanks and Fig. 2 the orifice tank. Mixing was done by hand, each mix receiving about 2 hours' agitation. From two to six mixes were made a day.

For further details respecting the operation of the plant the reader is referred to the paper mentioned above.

In another paper presented at the recent convention of the American Waterworks Association, Mr. West deals in detail with the use of liquid chlorine. In the course of his paper he presents the following objections to the use of hypochlorite of calcium and the method by which it was applied at the Torresdale filters:



Views of Torresdale Bleach Plant. Fig. 1 (left)—Mixing and Solution Tanks. Fig. 2 (right)—Orifice Tank.

(1) Variation in the strength of solution, due to variable quantities of available chlorine in the powder, and to the variation in the readiness with which the bleach mixes with water.

(2) Interruption to feed of solution, caused by corrosion of orifice or stopping of flow by lumps of sludge or choking of delivery pipe.

(3) Tastes and odors which create in all probability the most serious objection.

Historical Sketch of the Use of Liquid Chlorine in United States.—The credit for the introduction of liquid chlorine for water disinfection belongs to Major C. R. Darnell, who first tried it in June, 1910. He applied the chlorine in the form of a dry gas to the water to be treated. He later carried out a series of tests with an apparatus with a capacity of 500 gal. per hour.

In June, 1912, Dr. Geo. Ornstein constructed an experimental apparatus for the use of chlorine gas for water

and sewage sterilization employing a principle entirely different from Major Darnell, involving the absorption of the gas in water prior to its application to the fluid to be treated.

In September, 1912, S. M. Van Loan, Ass't-Chief Engineer, Philadelphia Bureau of Water, assisted by Geo. E. Thomas, chemist, Belmont Laboratory, experimented with liquid chlorine on a large scale at Belmont filter plant. They fed the chlorine into the filtered water basin in the form of gas, regulating the quantity by loss in weight of the containers; about 46 lbs. per day being applied to 36,000,000 gals. of water. With the approach of cold weather, the difficulty of freezing was encountered. Later the cylinder was jacketed and heated by a lamp.

Early in November, John A. Kienle, then chief engineer of the water department of Wilmington, Del., worked along similar lines at the Wilmington plant. By the use of high- and low-pressure valves he was able to regulate the flow of gas. His results were presented at the 1913 convention of the American Water Works Association. He worked in conjunction with the Electro-Bleaching Gas Company, who installed their apparatus January, 1913. This apparatus makes use of an absorption tower, whereby the chlorine is absorbed by a small amount of flowing water which carries it into the supply to be treated.

About the same time Dr. D. Jackson was experimenting at Ridgewood reservoir, Brooklyn, and shortly afterward put out the Leavitt-Jackson liquid chlorine machine. This machine operates on the basis of a balanced beam, feeding the gas according to loss in weight. The gas is fed directly into the water to be treated similarly to the Darnell apparatus.

The first complete set of results for a continued period are those from the Niagara Falls plant operated by the Western New York Filtration Company, under direction of H. F. Huy.

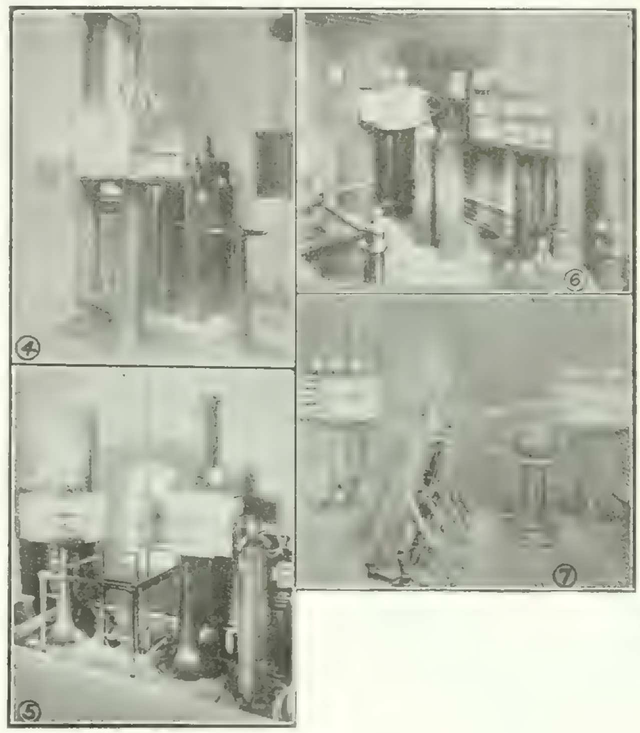
The first permanent liquid chlorine plant in Philadelphia was installed at Queen Lane filter plant September, 1913. A contract for 10 plants, two at each of the five filter plants, was awarded the Electro-Bleaching Gas Company for $9,750. The plants were installed during October and November, 1913; that at Torresdale starting November 25th. Fig. 3 shows the present liquid chlorine installation at Torresdale. Figs. 4, 5, 6 and 7 show similar plants at Queen Lane, Upper and Lower Roxboro and Belmont, respectively.

General Description of Apparatus.—From 4 to 8 cylinders of liquid chlorine are connected by means of flexible copper coils to a manifold with a valve for each cylinder. The manifold is connected with a gauge used to determine initial pressures. Beyond this gauge are two regulating valves; the first reducing the initial pressure to about 15 lbs. per sq. in. and the second regulating the pressure through a range sufficient to give the desired amount of gas. A low-pressure gauge, calibrated empirically, indicates the flow. The gas then passes through a ⅜-in. hard rubber pipe to the bottom of the first absorption tower. This tower is 8 ft. high and is filled with coke to give surface, and is sealed. The excess gas passes through a second pipe to the bottom of a second tower.

These towers, as well as all other parts from this point on, are made of hard rubber. Water is admitted through the top of the towers.

The chlorinated water passes through a horizontal pipe 58 ft. long 4 in. in diam. connected with eight drops ¾ in. in diam. extending to within one foot of the bottom of the chamber and protected from the current by 1½-in. iron casings. About three feet of flexible rubber hose is attached to the ends of these pipes. The ends of the hose are kept in motion by the swirl of the current.

Original Apparatus and Changes Thereto.—Owing to the large quantity of chlorine needed (as high as 10 lbs. per hour) it was planned to feed the chlorine in liquid form through the cylinder valve having an evaporator placed next to the high-pressure valve. This was done to prevent freezing owing to the reduction in temperature due to the rapid evaporation. Cradles were provided for inverting the cylinders. The evaporator was prevented from freezing by having a constant flow of water passing around it.



Views of Liquid Chlorine Installations at the Schuylkill River Plants in Philadelphia. Fig. 4—At Queen Lane; Fig. 5—At Upper Roxborough; Fig. 6—At Lower Roxborough; and Fig. 7—At Belmont.

From almost the start trouble was experienced. The needle and regulating valves of the apparatus gradually choked up with the impurities in the chlorine cylinders chiefly ferric chloride mixed with an oil-like substance with the consistency of petroleum. Liquid chlorine was allowed to pass through the feed pipe of the tower, corroding and choking this up, and found its way through the coil in the evaporator where it came in contact with the water used for cooling and the whole apparatus went out of commission.

When it was found impossible to supply the gas in this manner the cylinders were used vertically and an electrically heated cabinet with automatic thermostatic control was installed. This keeps the cylinders at a temperature of 75 deg. F., and but little trouble with freezing is experienced.

Results at Various Plants.—The paper then outlined the results from treatment at Torresdale, Belmont, Upper and Lower Roxborough, Queen Lane, Niagara Falls, N.Y., Wilmington, N.C., and Wilmington, Del.; comparing, whenever possible, in each case the chlorine with

corresponding hypo data. It also included results of liquid chlorine treatment with unfiltered water at Montreal. The Torresdale comparative results are given in the table at the foot of this page.

Advantages of Liquid Chlorine Over Chloride of Lime.—The author then dealt with the claims made for liquid chlorine, an analysis of which may prove of value.

(1) Liquid chlorine is an absolutely pure chemical, concentrated in small cylinders while chloride of lime is bulky, requiring large space for storing.

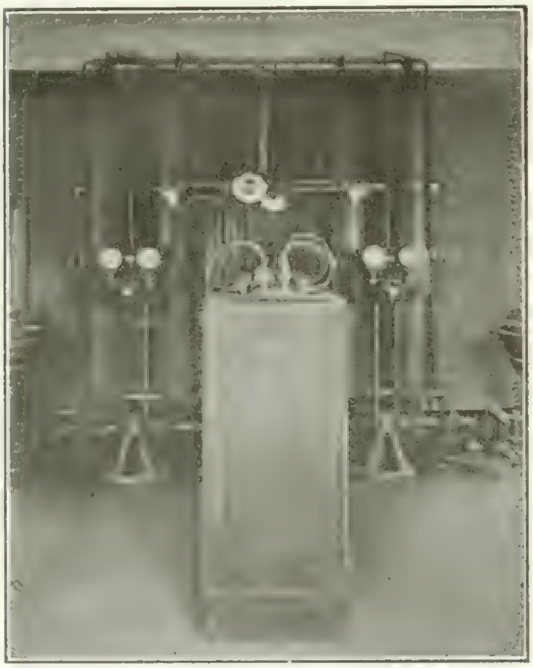


Fig. 3.—Torresdale Liquid Chlorine Plant.

(2) As to the saving in space required, a 100-lb. cylinder occupies 64 sq. in. floor space. A stock for 50 days at 200 lbs. a day would occupy a space of 45 sq. ft., 5 ft. high. About 20,000 lbs. of bleach, enough for but 17 days at 1,200 per day, would occupy (taking the can at 750 lbs. each) 160 sq. ft. On a basis of 6 to 1 about 10 to 11 times as much space is required for bleach as for liquid chlorine.

(3) With efficient controlling devices liquid chlorine will eliminate the disagreeable odors and corrosive influences of chloride of lime; consequently the installation may be placed in position where the use of chloride of lime is impossible. Ordinarily this is true. The odor of chlorine at Torresdale is hardly noticeable; but there are times when, due to carelessness or accidents, the atmosphere has been unbearable and chlorine has escaped in large amounts. (This has usually been caused by the failure of the water supply used for absorption and not by the apparatus.)

(4) Liquid chlorine will retain its full efficiency over unlimited time, whereas chloride of lime deteriorates rapidly. This is one of the best arguments for liquid chlorine, especially for small installations.

(5) The floor space occupied by liquid chlorine plants is small, whereas chloride of lime installations require large mixing tanks, etc. The space occupied at Torresdale for bleach treatment, independent of the space for weighing, was 22 x 16 ft. For the liquid chlorine apparatus the cabinet is 2 x 4.4 ft., and the space occupied by the towers is 10 x 2 ft.

(6) The reaction with liquid chlorine is simple, while that with chloride of lime is complex and less effective at low temperature.

(7) According to Dr. D. Jackson, 1 lb. liquid chlorine equals 9 lb. chloride of lime. According to J. A. Kienle it equals 8 lb. Theoretically, it should equal about 3 lb., but in practice considerable available chlorine is lost and the theoretical amount is nearer 1:4.

Huy, at Niagara Falls, claims to get as good results with 3 lb. of liquid chlorine per day with 6,000,000 gal. of water as he did with 30 lb. of powder. He added 30 lb. to the filter effluent. He adds 9 lb. liquid to the water in the sedimentation basin and 3 lb. to the effluent of the filters. The results are not quite comparable. At Torresdale, liquid chlorine is being used at the rate of about 1:6 to 1:7. It is quite possible that with careless handling and storing of bleach at small plants the figure is nearer 1:8 than 1:6.

(8) No taste or odor appears in water treated with liquid chlorine. Major Darnell states that at least two parts of liquid chlorine, equivalent to 16 lb. per million gal., must be used to give the slightest taste to Potomac River water. Huy stated that when using 5 lb. per million gal. a slight taste was noticed in the laboratory directly after dosing. On a test at Middletown, Conn., 14 lb. per million gal. were used without its being noticed. It is quite possible that if the dosage is heavy enough the water will have a taste, but figuring on a basis of 6:1, 30 lb. of chloride of lime would be needed to correspond to Huy's 5 lb. and 80 lb. to the amount mentioned by Darnell. From a close examination of the literature on

Comparative Results of Treatment With Bleach and Liquid Chlorine at Torresdale.

Date.	Treatment per million gallons.	—Bacteria per cu. cm.— Applied.	Filt.	Treated.	Per cent. removed.	—B. coli in— 1 cu.cm.	10 cu.cm.
Feb. 22-March 31, 1912	9-lb. bleach	17,000	760	260	64	2	13
Feb. 22-March 31, 1914	1.3 lb. liq. cl.	6,800	320	30	90	0	5
Jan. 1-Feb. 28, 1914	4.5 lb. bleach; 0.8 lb. liq. cl.	12,000	710	118	83	0	5
January, 1913	870 lb. bleach; 150 lb. liq. cl.*	13,500	900	227	75	2	5
March, 1913	234 lb. liq. cl.*	7,200	305	27	91	0	3
November, 1913	1620 lb. bleach; 90 lb. liq. cl.*	8,500	170	31	82	1	8
March, 1914	234 lb. liq. cl.*	7,200	305	27	91	0	3
April, 1913	7-lb. bleach	3,320	50	10	80	0	0
April, 1914	1-lb. liq. cl.	2,070	89	11	88	0	1
February, 1914	800 lb. bleach; 1-lb. liq. cl.	7,250	460	99	78	..	4
March, 1914	1.3-lb. liq. cl.	7,200	305	27	91	0	10

*Per day.

chloride of lime and from personal observation, the amount of chloride of lime that will give a taste to water may be estimated at from 7 to 20 lb. per million gal., the average figure being from 10 to 12.

(9) Liquid chlorine does not change the character or the water by the introduction of lime salts. The lime salts will usually amount to not over one part per million.

(10) Liquid chlorine necessitates no labor cost while chloride of lime does. This is true, but a liquid chlorine requires skilled supervision to be operated properly and is not fool-proof.

(11) Liquid chlorine leaves no sludge.

(12) Liquid chlorine will reduce the amount of alum needed for bacterial removal. There can be no question but that in cases where the water is comparatively clear and where alum is used chiefly for bacteria removal if liquid chlorine is used before filtration it will make a marked saving in the cost of alum and in many cases will not only pay for itself but will decrease the general cost of the plant.

A saving of ½ grain per gal. of alum at 1c. per lb. by the use of 1 lb. liquid chlorine per million gal. at 10c. means a saving of 61c. per million gal.

(13) The feed of liquid chlorine is regular from hour to hour while the feed of chloride of lime varies constantly.

Objections to Use of Liquid Chlorine.—The chief objection to the use of liquid chlorine lies in the concentrated energy of the material itself. If liquid chlorine is set free in small enclosures it will cause nausea. With ordinary common sense and judgment on the part of the operator this is not likely to happen. The greatest danger lies in faulty cylinders and faulty valves. If the cylinder valve will not turn off or if the cylinder leaks it must be gotten out to the open air and the chlorine allowed to escape. Careful inspections of cylinders and valves must be made.

When it comes in contact with moisture, liquid chlorine has a very corrosive action, but this has been overcome by the use of hard rubber pipes and towers.

Comparative Costs.—The following estimated comparative figures are submitted:

Chloride of lime costs us from $1.22 to $1.70 per 100 lb.; the usual quotation was $1.34 and the average figure $1.40. We used during 1913 an average of a little over 1,200 lb. a day, or $16.80 a day for powder. Two laborers at 25c. per hour were employed for eight haurs, making a total cost of $20.80 per day, exclusive of repairs, sample collecting, or laboratory analyses.

180 lb. of liquid chlorine would cost, at 10c. per lb., $18 per day. We have now passed the worst conditions of the year, February and March, when we used 234 lb. a day or $23.40 cost. It is expected that we will be able to reduce the amount of liquid chlorine to at least ¾ lb. per million, or 120 lb. a day.

Some supervision and handling of cylinders is required. At present the work is done by a $3 a day mechanic, who also keeps the pre-filters in repair. His wages is charged against the pre-filters. A charge of $1 per day would be fair for this service. This is partly balanced by the discontinuance of laboratory analyses.

The labor cost during 1913 of $4 per day at Torresdale, with its output of 180,000,000 gal., amounted to but 2.2c. per million gal. At Belmont and at Queen Lane the labor cost of about $1.50 per day amounted to 3.8c and 3c. respectively. At Roxborough plants the labor cost averaged over $1 per day for mixing, that at Lower Roxborough cost 10c. per million, and at Upper Roxborough 6.7c. per million. The cost per million gallons at these plants during 1913 amounted to from 16 to 18c. At 1 lb. per million gal. for liquid chlorine the cost would be 10c., or a saving of 6.8c. per million gal. On April 14th the quantity used was reduced to ½ lb. per million gal., or a cost of 5c., a saving of from 11 to 13c.

Belmont and Queen Lane are saving a labor cost of 3.8 and 3c. Belmont is operating at a rate of ½ lb. and Queen Lane at ¾ lb., or about 5 and 7.5c.

In general, the cost of the two processes should be about equal, but liquid chlorine should prove the cheaper of the two.

With the use of liquid chlorine it is necessary to have an accurate determination of the flow of gas; it must be kept in a condition that it will not corrode the apparatus, and a proper absorption of the gas must be obtained. This has been accomplished by the use of absorption towers, which require from 50 to 100 gal. of water per 1 lb. of chlorine used.

While in some instances liquid chlorine may prove more costly than chloride of lime, the regularity with which it can be applied, the more effective the action on pathogenic bacteria, the small compact apparatus and the absence of the odor of chlorine around the plant recommends it as a satisfactory substitute for hypochlorite, possessing as it does all the advantages of the latter and only some of the faults.

It has been shown from experiments conducted in Belgium with a view to discovering the effect of foreign metals on the rolling of zinc, that ingots weighing 40 lb. were prepared by casting together zinc alloys of various metals, with spelter containing lead 1.05 to 1.25, cadmium 0.076 to 0.11, and iron 0.03 to 0.039 per cent. It was found that cadmium is harmful above 0.25 per cent., while with 0.5 per cent. rolling is impossible. In regard to arsenic, 0.02 per cent. markedly increases the hardness, and with 0.03 per cent. the metal is too brittle for practical purposes. Antimony is less objectionable than arsenic as regards hardness, as 0.07 per cent. does not increase the hardness; but 0.02 per cent. is enough to produce a striated surface on the rolled sheet, which makes it unsaleable. Tin is objectionable when above 0.01, and prohibitive at 0.03 per cent. Copper has no hardening effect until it reaches 0.08, and with 0.19 per cent. the zinc is unworkable. A permissible maximum of iron is 0.12 per cent., but this is easily reduced in refining. Though 1 to 1.25 per cent. of lead does not interfere with the rolling, a slight increase not only seriously affects malleability, but the excess of lead remains unalloyed and forms patches on the sheet. The presence of two or more impurities together results in a combination of the injurious effects of each.

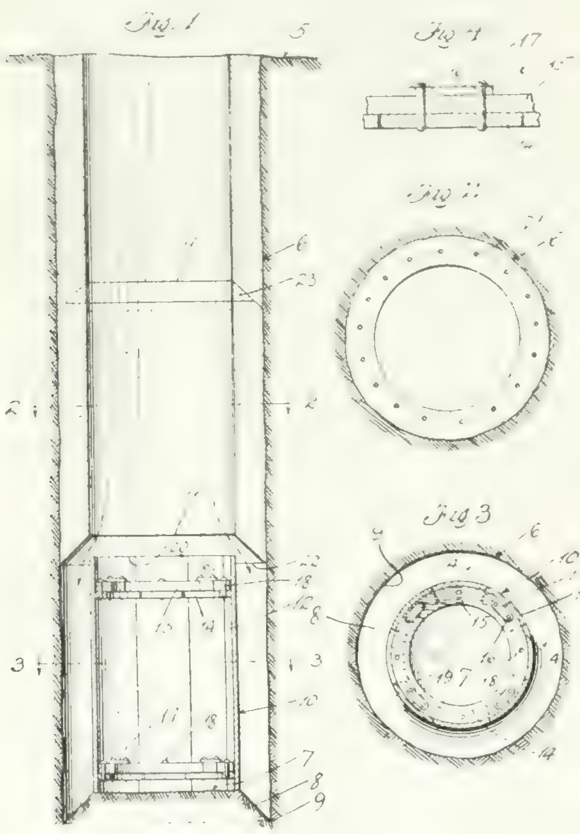
"Le Genie Civil" reports the results of tests made at the Ecole Centrale, Paris, to show that when holes are drilled and then reamed in soft-steel bars the metal materially increases in strength, the average limit of elasticity improving 12.3 per cent. and the average tensile strength 9.2 per cent. This phenomenon is explained thus:—In putting together the parts of a test piece broken under tension, it is found that the two ends do not coincide; and that, while the edges make a good contact, the central parts do not, thus indicating that the rupture begins at the centre, and that the edges have a higher tensile resistance than there is along the axis of the bar. Therefore, if several holes are drilled so as not to injure the material too much, as might be the case with punching, the average tensile strength of the section across the holes, per unit of metal, will be higher than before the holes were drilled, since each hole creates, so to speak, additional edges.

METHOD OF LINING CONCRETE SHAFTS.

A PATENT recently issued in the United States (No. 1089573) relates to a method of lining shafts with concrete, the principal object being to provide a method to eliminate the building of elaborate retaining walls in a well shaft. It is also an object to provide a method by which the concrete may be inserted in sections progressively from the top or ground level downward.

Fig. 1 is a central longitudinal section of a shaft showing two of the sections of concrete introduced, and the form in position ready to place the next succeeding section of the lining. Fig. 2 is a cross-section on the line 2—2 of Fig. 1, viewed in the direction indicated by the arrows. Fig. 3 is a cross-section of the shaft on the line 3—3 of Fig. 1, viewed in the direction indicated by the arrows. Fig. 4 is a detail section on the line 4—4 of Fig. 3, viewed in the direction indicated by the arrows.

Heretofore in the lining of shafts with concrete the shaft has first been sunk or dug the required depth, requiring a temporary lining to retain the walls of the shaft intact and prevent caving in upon the operators. Then this supporting lining either has to be removed or become a loss by being left in the shaft while the forms are inserted and the lining introduced from the bottom upward, the entrance of water in the lower end of the shaft or intermediate positions complicating this process.



This invention overcomes the above difficulties by providing a method by which the shaft is enclosed with the permanent lining as the work progresses downward without great delay, and materially reducing the cost and increasing the efficiency of the structure.

In the drawing, numerals are used to designate the same parts in the different views, 5 designating the surface of the ground, and 6 the shaft vertically dug therein by any suitable means or apparatus, the method preferably used being to dig the shaft a depth equal to the height of the collapsible form preferably used. In practice this form is about 6 ft. in length, depending on the character of the soil through which the shaft is being sunk. The section dug is preferably as indicated, in the lower portion of Fig. 1, so as to provide the platform 7 of a diameter equal to the diameter of the finished shaft, from this point downwardly and outwardly, being excavated to leave the inclined face 8 until the concentric periphery of the major diameter of the shaft is met at the point 9. On this platform 7 the collapsible form 10 is erected, the upper edge of which falls slightly below the inner edge 11 of a previously formed section. The form 10 is preferably formed of a plurality of vertical sections 12 each of which is provided with a flange 14 secured thereto at suitable distances, the flanges, when various sections are placed adjacent one to another, abutting to form the circular configuration or cylinder, upon which flanges are supported the 4 sections of the rim 15, which are held together by suitable means, as pins 16 passed through the locking plate 17 together with the pins 18, which pass through the flanges 14 and the rim 15 intermediate of the locking plates 17. One of these sections is necessarily cut away as indicated in dotted lines at 19 so that this section may be removed to allow the collapse of the form after the concrete has been inserted.

As before stated, the concrete is introduced between the upper edge 20 of the form and the lower inner edge 11 of the previously formed section of the concrete lining, which is preferably reinforced by the vertical rods 21 supported in any well known manner. This upper edge 20 preferably extends a slight distance above the lower edge 22 of the last section of the concrete lining.

The shaft is preferably dug during the day the required depth, then the process of tamping the concrete lining in place is performed, and the concrete left to cure over night, while the man is otherwise occupied. The concrete sufficiently sets to permit the removal of the forms the next morning, and the shaft is sunk the corresponding distance only limited by the length of the form used. The triangular space 23 is filled either before the removal of the form and troweled in position, or inserted afterwards, as may be found preferable.

In an excavation having a lining of this character, the cost over usual constructions has been reduced approximately one-half, together with the material increase in speed of construction, and with greater assurances of safety, the irregular portions of the shaft walls firmly grasping the concrete sections, and preventing sliding as well as the connection to one another by adhesion, or suitable connections between the reinforcing rods.

The method is described to considerable length in "The Mining World" of recent date. Mr. Edward Morlae is the inventor.

A very notable feature of the recent convention of the American Water Works Association was the devoting of an entire day to the interests of the superintendents and others closely associated with the operation and maintenance of waterworks. The morning and afternoon sessions were devoted to the discussion of subjects introduced in the printed "question box" of the association. These subjects, dealing chiefly with water meters, dwelt upon such points as their setting, testing, design, maintenance and repair. Superintendent's day turned out to be a very important one for those dealing with the practical rather than the scientific phases of such work.

Editorial

CONSULTING ENGINEERS AND MUNICIPALITIES.

One regrettable feature of the whole attitude of the public to the engineering profession is that it is the layman himself who has produced the circumstances to which this not overly healthy attitude is to be attributed. So long as he allows political and personal influences to interfere in the selection of engineering assistance, and in the disposition of experts' reports, engineering will not be regarded by the man of the street as belonging to a plane any higher than it is now. Rather than maintaining the title of profession, argument is not lacking in instances where it is so unfortunate as to be lower in repute than the union-protected trades which follow in its wake.

Take, as an example, the consulting engineer—the highest type of which engineering can boast—the profession department as distinguished from the practice. A municipality has before it a project with an engineering problem attached. A consulting expert is called in to make a report upon what engineering it entails and its estimated costs of construction and operation. He gives it a thorough study, wherein his technical training and ability unite with his practical experience, grown out of a series of similar problems during his career, and are applied to the local conditions and requirements. He submits his report, presents his bill, receives his fee, and the transaction is closed. The municipality sought expert advice, got it, paid for it. The solution of the problem is before the peoples' administration board. The next step is to go ahead with the development.

But how prone Canadian civic officials are to question the value of the technical services they have purchased. The plans may fail to suit the inclinations of an aldermanic official or two, and if the influence from this quarter is sufficient the report is sidetracked and the question lies dormant while ratepayers are expecting daily to hear the sound of pick and shovel. Eventually the problem is revived, and another consultant is called. Obviously, he understands that the previous report was unsatisfactory, and that his scheme must have a different basis.

Thus, besides a split in administrative ranks, there are added expenditures, and delays in getting the development under way. There is also a depreciatory effect upon the engineering profession in the minds of the ratepayers, besides a tendency toward breaches of professionalism among engineers themselves.

So many instances of the above state of affairs have developed during the past few years that one may safely acknowledge it a serious detriment to the development of the country and to the welfare of the engineering profession. In many of our towns and cities the application of expert engineering advice to the problems of the day has been shamefully manhandled.

If civic officials are fearful of encountering incompetency in retaining such services and are afterwards dubious of placing dependence upon the advice, whatever it may be, they should not be slow to realize that in the engineering profession itself rests a reliable safeguard against mistakes. The condition is not unlike a transitory stage in the history of England, not so many years removed as to be incomparable. For upwards of a century municipal problems were often subjected to incompetency at the hands of would-be engineers who did not hesitate to attack any problem for a cut-rate fee, and whose schemes frequently resulted in enormous useless expenditures on construction of works which necessitated abandonment after a short period of unsuccessful operation. The establishment of the Local Government Board, equipped with an engineering department whose duties included the thorough examination of every scheme, has resulted in a cessation of such unfortunate occurrences and eliminated the engineering-adventurer.

Canada, with her formidable array of engineering problems, might well establish a similar institution for the purpose of checking risk and excessive expenditure in the engineering work of her municipalities. It should be necessary for every scheme to pass muster, in the minute and exhaustive inspection of a board of officials comprising the best engineering talent in the country. Millions of dollars would be saved; delays, detrimental to the health and comfort of the people, would be dispensed with, and engineers would encounter a more optimistic and encouraging tone among their fellow-men.

Such a board would deal with reports, rejecting or approving of them as their quality merited, and let the city councils choose whom they might as a consultant, his report upon the proposed development would have to depend entirely on its merits.

POWER DEVELOPMENT ON ST. MARY'S RIVER.

Occasional reference has been made in these columns to the work of the International Joint Commission, and to the questions which have at various times been presented to it by the Canadian and United States Governments, since its inception in 1909. The most recent findings of the Commission have been in connection with the applications of the Algoma Steel Corporation, Limited, and the Michigan Northern Power Company for the diversion of water for power purposes and the construction of compensating works in the St. Mary's River at Sault Ste. Marie.

After approximately twenty months of investigation official approval was given in Ottawa last week for the diversion of about 30,000 cubic feet per second on either side.

The primary importance of conserving the present conditions for navigation was evidently the chief contending factor in the extended investigation. Shipping interests on the Great Lakes commanded practically no molestation in the St. Mary's River. With this in mind, the recent judgment is found to possess significant features in the interests of navigation. The diversion for power purposes is contingent upon the erection of sixteen sluice gates across the river to compensate for it. These sluice gates are to be under the absolute control of an international board composed of two engineers representing the governments, and whose duty it will be to maintain Lake Superior at a level best suited to navigation and to the various communities along its shores.

LETTERS TO THE EDITOR.

"Road Building Economics."

Sir,—The writer has read the paper entitled "Road Building Economics," by Mr. Reginald Trautschold, M.E., in your issue of May 14th, but takes exception to some of the author's statements in regard to asphalt paved streets.

The subject "Asphalt Paved Streets" is, to begin with, quite vague, for there are several types of asphalt paving in use to-day and their variations in cost and life are too great to be covered by a single formula. It is presumed, however, that the author refers to the standard sheet asphalt construction consisting of concrete base, binder course and wearing surface.

Mr. Trautschold states that

> "The softening of the paving surface, if subjected to even the summer temperature of many localities, limits the use of this class of roads to cities in the temperate zone, in even which localities the softening of the asphalt surface has much to do with the very high maintenance charge. . . . ."

This statement is indeed a surprise, for it is now well known that such softening, as well as cracking with cold, can be to a great extent taken care of by properly designing the paving mixture.

Asphalt cement, the binding medium, is not a material of fixed characteristics and the engineer has at his disposal not only the various consistencies but the different brands of bituminous materials as well. If he is properly advised as to this feature and the mineral aggregate is properly selected and graded, there is no reason why the sheet asphalt pavement should not be successful even in greater extremes of temperature than now employed. It is noiseless, sanitary and can withstand the heaviest traffic, as is shown by the fact that it is to-day replacing the old stone pavements hitherto considered necessary in business districts.

Your author's formula must certainly be founded upon inferior construction for, with proper materials and supervisions, the life of the sheet asphalt pavement should be considerably over ten years. I quote, for instance, the following statement from the Report of the Engineer Commissioner of the District of Columbia for the year ended June 30th, 1909:

> "Many of the asphalt pavements . . . have been down for from 20 to 37 years, and . . . about 20 years represent the effective and economical life of such pavement."

The District of Columbia was the pioneer in asphalt paving construction and, with its data 40 years' experience, the above testimony would seem most competent. Furthermore, the science has progressed considerably in the five years since the report was written.

A study of these facts and the present competition in bituminous materials will serve to reduce Mr. Trautschold's cost and maintenance charges and show this type of pavement to have, after all, an individual economic value.

LEROY M. LAW.

Baltimore, Md., June 2nd, 1914.

"Determination of Areas of Cross-sections."

Sir,—In your issue of March 12th, 1914, there appears an article by Mr. C. D. Norton entitled "A Method of Determining the Area of Cross-sections." It is a singular coincidence, but the method in question is almost identical with one worked out by the writer over a year ago now, and which early in February, 1914, in the form of a booklet, was published and copyrighted both in Canada and the United States.

A copy of the booklet for your information is sent herewith, and those interested will also find a resumé of the subject matter in it in "Engineering News," issue of May 28, 1914.

Mr. Norton, however, in his article, does not show that it is quite unnecessary to ascertain the actual cuts or fills at the various points on the cross-section for the rod readings as taken, at these points, with far less labor and with less liability to error, can quite as well be used. In the writer's opinion this very point is of vital importance when considering the method from the point of view of a time-saving device.

For instance, on page 6 of the booklet, the information there given for each particular section, of necessity, must be obtained in the field and noted in the level book in one form or another.

In order to obtain the area of the section, however, as it happens, nothing more is required; the very figures given there are used in the calculation. In plain language, each horizontal distance to a point has been multiplied by the difference between the rod readings of the points coming immediately after and before such point, one-half the sum of such multiplications giving the total end area of the sections.

While at first sight the above might appear slightly complicated, it will be found that in practice, once one has become familiar with it, the whole operation is an exceedingly simple one. The difference in the rod readings can usually be obtained mentally and jotted down directly on one page of the level book with corresponding horizontal distance, where at any subsequent time such figures and resulting end areas can very easily be checked by an assistant.

It is the intention to have the booklet mentioned above bound up with other tables in the front of the ordinary blank level book, where, whenever required, the method will be available to all who desire to save time by using it. The cost of the level book to the engineer will not, of course, be increased by this insertion.

E. S. M. LOVELACE,
Consulting Civil Engineer.

Montreal, June 5th, 1914.

It has been reported from Cordova, Alaska, that actual work on the survey of possible routes for the government's railway in Alaska was begun on June 2, when the first stake was driven at Chitana by a reconnaisance party under Henry Deyer, who will survey the route from Chitana, where the Fairbanks railroad leaves Copper River and Northwestern railway to the coal field.

Capitalists of Yokohama are engaged upon the preparation of plans for the construction of a dock at Namamugi, a suburb of Yokohama. According to the plans 344,134 tsubo of water front will be reclaimed and divided into four divisions. The first division will be used for docks, the second for shipbuilding and on the third and fourth several houses will be built. It has been estimated that the expenditure will be Y.2,234,000, and the work is expected to be completed in 5 years.

BULKLEY RIVER BRIDGE, BRITISH COLUMBIA.

Across the Bulkley River at Hagwilgate, near New Hazelton, B.C., has been erected a single span suspension bridge which ranks among the highest of its type in existence, being 250 ft. above the water level. The span is provided with stiffening girders to curtail vibratory and undulating movements under traffic and wind. It is the first of its kind, according to the builders, Messrs. Geo. Cradock & Co., wire rope manufacturers and engineers, of Wakefield, England, to be hung from catenaries of locked coil cables, the latter being claimed not to rotate or lengthen.

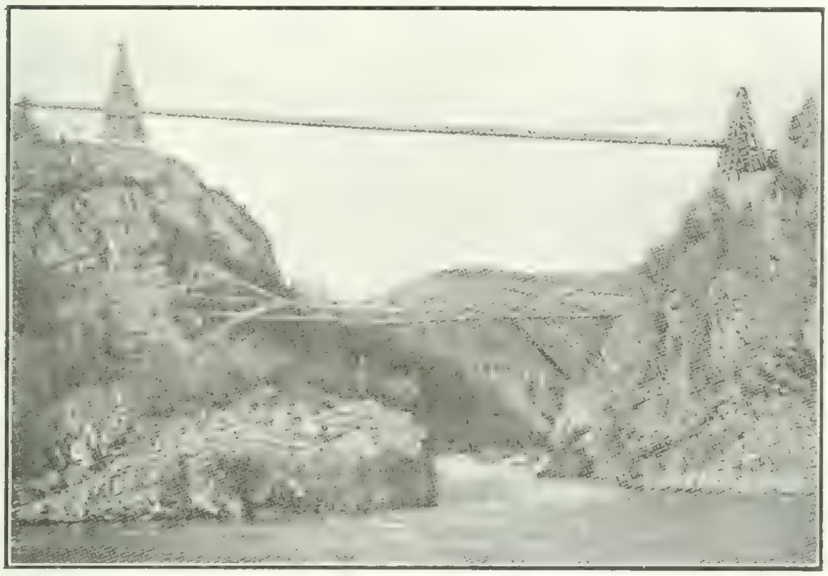


Fig. 1.—View of Bulkley River Suspension Bridge.

Fig. 2.—View of the Structure from One of the Approaches.

It spans the Bulkley River at a point where it is confined between the walls of a rugged canyon, as shown in Fig. 1. The span itself is 451 ft. in length, the whole structure being over 600 ft. in length when approaches are included, with a roadway 9 ft. in width. The bridge is suspended from timber towers 65½ ft. high, one of which has been mounted upon the solid rock, while the other is furnished with a concrete pier foundation. The cables, 2½ in. in diameter, are each anchored by 3-in. steel bolts embedded in concrete blocks approximately 15 x 20 ft. in dimension. The suspension rods are ¾ of an inch in diameter, and are clamped to the suspension cable at the top, while the bottoms are thickened to ⅞ of an inch and threaded. These rods are placed 4 ft. apart on either side and carry the floor beams, also 4 ft. centre to centre, diagonally braced. These floor beams support 4 x 7-in. stringers, upon which is laid the floor of the bridge consisting of 3 x 4-in. plank. The timber is all of British Columbia fir. Over 50 tons of steel have been used in the construction of the bridge. The coiled locked cable has a tensile strength of 350 tons and the bridge itself is designed to safely carry a rolling load of 18,000 lbs.

The stiffening steel girders forming the sides of the bridge are of lattice type and extend from the floor to the hand-rail.

The contract for the construction of the bridge was awarded in 1912, but owing to the severity of the winter in northern British Columbia no work was attempted before the spring of 1913, whereupon Mr. Percy Cradock, one of the directors of the firm, took charge of the construction. The entire structure was completed in the course of two months after the foundations had been built. Fig. 3 illustrates the hazardous construction work associated with it.

The work was carried out for the New Hazelton Bridge and Power Co., and accommodates the vehicular and pedestrian traffic of the Bulkley valley.

Fig. 3.—Bulkley River Bridge in Early Stage of Construction.

Fig. 1 also shows an old structure which has been used for years as a means of transportation across the river. It was built by Indians and is in striking contrast to the new structure suspended above it. The members of the old Indian structure are held together by wooden pegs, no nails having been used in it.

ROAD IMPROVEMENT COMPETITION IN SASKATCHEWAN.

The annual road drag competition established last year by the Highway Commission of Saskatchewan started on June 1st and will be continued through June, July, August and September. In the early part of October all competing roads will be inspected simultaneously and the prizes awarded according to the points earned during the period of dragging.

THE BULK HANDLING OF CEMENT.*

By H. M. Capron,
President of Marsh-Capron Mfg. Co., Chicago, Ill.

THE use of cement in bulk is comparatively new. The writer's interest and experience with bulk cement started with the mechanical problems involved in handling and storing the cement and other aggregates at the mixing plant, the measuring and conveying them to the mixer, and the mixing and handling of concrete.

Some of the large cement companies, and a few progressive contractors have recently been studying this problem. Like all new ideas, however, its beneficiaries accept it reluctantly, and its advocates are subject to the criticism and ridicule which greets all pioneers.

It is a remarkable commentary on human nature that the people who are to be benefited by a new idea are the slowest to adopt it: and it is equally significant that once a contractor has used bulk cement, he becomes one of its most enthusiastic converts.

It requires no little originality, and a great deal of courage to depart from a custom of years' standing in any line of business, and such departure must of necessity be founded upon logic which is absolutely sound.

Ever since Portland cement became a factor in the contracting business it has been delivered to the ultimate consumer in packages. At first wooden barrels were used, but they were so cumbersome and difficult to handle that a small package was substituted, and now cement is handled almost universally in cloth sacks, or paper bags, four of them constituting the commercial unit, the barrel.

Cement is only one of the component parts of concrete. The fine and coarse aggregates—sand, gravel and stone—have always been handled in bulk, and an inquiring mind uninfluenced by business custom would naturally ask, "Why should cement be delivered in packages when the other aggregates are always used in bulk?" Careful consideration of the subject showed many reasons why cement packages could, and should, be eliminated from a great many classes of concrete work, and to demonstrate the practicability of this new idea, the originators presented it to certain contractors for their favorable consideration, which was at last secured.

The present age is one essentially of conservation, not of conservatism, and if it can be satisfactorily shown that there is an economic waste in packing cement in sacks only to reduce it to the bulk condition before it can be used, the attention of every contractor who must necessarily pay for this packing and unpacking of cement is immediately challenged. If the contractor can be relieved of this expense and can at the same time purchase his cement for a smaller figure, it is obvious that there will be larger margin of profit for him in his work, and those who adopt this method first will have the greatest advantage over their competitors.

The cement company which developed this idea offers cement in bulk for 42 cents per barrel less than the price of cement in cloth sacks. Forty cents of this is, of course, represented by the cloth sacks themselves, and two cents represents the saving to the cement company in packing and loading cement in bulk. Therefore, as far as the manufacturer is concerned, the only saving in this method is in elimination of the cloth sacks which would otherwise be used. This, of course, relieves the manufacturer of the cost of counting, inspecting, cleaning, and repairing these sacks when they are returned to the mill by the contractor for credit. On the other hand, new machinery is necessary to load and weigh bulk cement when it is placed in cars. A device called a weightometer has been adapted for this purpose. This machine consists of a belt upon which the cement is conveyed into the car. This belt passes through the weightometer and all the cement on it is automatically weighed and recorded by the machine, so that the operator can tell by a glance at the dial exactly how many pounds of cement have passed through the machine into the car. A car of bulk cement, therefore, in being loaded, is weighed as a unit. When it is loaded, figuring as is done in the United States, 376 pounds to the barrel of cement, and assuming that the car is to contain 250 barrels, the belt is stopped when the dial registers 94,000 pounds, and the entire car is thus weighed in one operation. If the same car is loaded with cement in cloth sacks, 1,000 sacks would be required, and likewise the necessity of weighing 1,000 separate objects. Thus the liability of error in weighing is reduced from 1,000 chances to one. It is, of course, the object of every honest manufacturer of cement to furnish correct weight, and cement in bulk represents the most satisfactory way of doing this.

Some doubt may be raised as to the difficulty in protecting the cement from moisture, both in transit from the mill and at the mixing plant, but this has proved to be purely theoretical.

The damage to bulk cement in transit by reason of a leaky car is by actual experiment shown to be 50% of the damage the same amount of water would inflict if falling on cement in cloth sacks. The reason for this is that when water comes in contact with the cotton cloth, by capillary attraction it spreads to the adjacent sacks so that a leak in a car roof will frequently ruin a whole tier of sacks from top to bottom of the car, and damage a large part of the cement contained in these sacks. If water falls on bulk cement it is absorbed immediately where it falls and the resulting damage consists of a crust of cement depending in size on the amount of water, and the damage is confined to the spot immediately under the leak, and all the damaged cement can be lifted from the car in this cake.

Experience has shown that the handling of bulk cement does not raise as much dust as cement in cloth sacks. The cement sifts through the sacks with the many handlings so the natural cohesion between the particles is broken and the dust is blown away or falls off. The method of handling it in bulk saves all this waste. The method of handling, of course, varies with the physical conditions surrounding the work.

In the early stages of the development of bulk cement shipment, the material was handled successfully and in large quantities by contractors who did not spend a single cent on special equipment. They reasoned that if they could handle and measure the sand and stone (which is 90% of the concrete job) by means of wheelbarrows, they could handle and measure the 10% of cement that it would require, with equal accuracy and facility. A great many jobs of considerable magnitude are still being carried on in this way, but naturally the possibilities of bulk cement in saving labor and increasing the output of a concreting plant may be more fully realized by means of equipment more particularly adapted to the work. When the work is adjacent to a railroad track and the size of the job warrants it, a bin may be constructed

*[illegible] at the First Canadian and International Good [illegible] Congress in Montreal, May [illegible], 1914.

alongside the track into which the bulk cement is conveyed by means of the bucket elevator. On one side of this bin is built a hopper for the coarse aggregate, and on the other side one for the fine aggregate. Both of these aggregates feed from the bottom of their respective hoppers, through spouts, into the mixer hopper. Experience has shown that a non-tilting type of concrete mixer lends itself best to a plant of this kind, as it requires less head room. These aggregates are handled from the cars into these hoppers by a clam-shell operated by a standard hoisting engine or by the same bucket elevator used in elevating the cement.

The bulk cement is moved from the car by a scraper similar to that used for unloading grain. With this the cement is scraped from the door of the car into the chute which feeds into the bottom of the elevator leg. From the bin the cement falls by gravity through a measuring box into the mixer hopper. Thus we see that the only labor connected with delivering the cement into the mixer is that required to unload the car with the device above described. Two men in one hour can easily unload a car containing 250 barrels of cement in bulk. By this method the contractor is saved the cost of the labor which otherwise would be necessary to perform the following activities:—

1. Carry the cement, sack by sack, from the car to the storage shed, and pile in shed.

2. Carry the cement, sack by sack, from the storage shed to the mixer platform.

3. Untie each sack and empty the cement, sack by sack, into the mixer hopper.

4. Shake out the empty sacks over the mixer-hopper to relieve them of all their contents.

5. Lay the sacks aside to be bundled.

6. Bundle the empty sacks for shipment to the mill.

7. Remove the bundles of empty sacks to the storage shed to await the accumulation of a shipment.

8. Load the bundles of empty sacks into a car for shipment to the mill, prepaying the freight on them. Then ensues a long wait while the sacks go to the mill, and are counted and inspected there before a credit can be issued on them and a cheque sent to the contractor for the value of the good sacks found in the shipment.

In every one of these eight stages the sacks are liable to damage by abuse of careless workmen, by exposure to the weather, and in many other ways. Sacks also make convenient aprons for workmen, tool bags, cushions for drivers to sit on, and it is reported that even shirts made of cement sack are stylish among some workmen. The loss on a job of this kind in all of its many phases, is variously estimated by contractors at from five to ten cents per barrel on the amount of cement used.

Every contractor who handles Portland cement recognizes that the empty cement sack is the most fruitful source of dispute with the manufacturer, of loss on the job, and of general inconvenience in handling cement. Everyone will instantly recognize that the elimination of the sack on the job would be a great boon. If, besides securing the advantages incident to removing the sack entirely from the work, the contractor finds himself relieved of a large item for labor in handling these sacks, both full and empty, there is no question that his best interests demand that he use cement in bulk wherever feasible. Where the mixing plant is removed from the railroad track 100 ft. or more, belt conveyers have been used to take the cement from the car to the elevator connected with the overhead bin. The fine and coarse aggregates may be handled over the same belt into bins provided for them, so that the gravity-feed into the mixer hopper can be applied to all of the materials going into the mixer. The number of laborers saved by this kind of an arrangement varies with the magnitude of the job and in any case the saving well repays the contractor for the installation of the necessary handling machinery and for the construction of these overhead bins. But, as already stated, the physical conditions of each job will require an arrangement best suited for its individual need. Cement in bulk takes up less room on the job, which is sometimes very desirable. Take as an illustration a large paving job which came to the writer's attention recently. This job requires 30,000 barrels of cement which means 120,000 sacks. At 10 cents per sack it takes $12,000 more to finance the job than if the cement were delivered in bulk. This bag money is tied up until credit is received from the manufacturer for sacks returned and every contractor knows how long it takes to get this credit.

Figure the average loss of sacks and interest on money invested in this case as 10 cents per barrel, or $3,000 actual loss, to say nothing of extra labor required in handling all these sacks; in any case the amount of capital necessary to finance the job is materially reduced.

It is quite evident that this subject is worthy of study by all contractors on large work.

TOWN PLANNING.

"Conservation," issued monthly by the Conservation Commission of Canada, makes the following statements and definitions about the subject of town planning:

It is the selection of the site and environment, and the adaptation of the same for settlement by an intelligent method, having in view health, amenity and convenience.

It is not a fad, but simply an orderly method of doing what must be done in any case.

It means life for the babies, and better health for each person in the town.

It assures to mothers and children as healthful homes and home environment as the factory act provides healthy workshops for mechanics.

It supplies suitable streets for all sections, whether residential or industrial.

It provides for cheap and rapid transportation.

It gives the children playgrounds in lieu of dusty streets and dirty lanes.

It prevents the undue encroachment of business upon residential areas.

It allocates to factories their proper place.

It is an important factor in giving a higher morality to the people.

It bestows on the many advantages at present only possible to the few, giving to the poor blessings denied them under existing methods.

It pays, because it is of economic value to the municipality permitting it to acquire property, which is sure to enhance in value at a minimum of cost.

It is what all should work and strive for, ennobles citizenship and elevates the nation.

The 1914 convention committee of the American Electric Railway Association, acting with the committee of the American Electric Railway Manufacturers' Association, has decided upon Atlantic City as the location for the 1914 convention. The dates are October 12 to 16.

FACTORS IN ROAD ECONOMY.*

By Will P. Blair,
Secretary, National Paving Brick Manufacturers' Association, Cleveland, O.

WHAT is the economic value of a road? By what shall it be measured? Shall it be measured by comparison with other roads or with roads built of other materials, or shall it be reckoned upon its own merits separate and apart from any comparison? Comparisons are said to be odious and are therefore interpreted as coming within a class of criticism that to some seems objectionable. The writer sometimes thinks, however, that the relative merit of paving material ought to be brought out by the sharpest kind of contrast. Unquestionably in the discussion of pavements and their worth, had they heretofore been considered in such meetings as this and through the columns of papers that are devoted to road and street building upon their relative worth, the public would by this time have been saved thousands of dollars. Much of the money that has been wasted in experiments would have been saved by the force and influence of a discriminating reason and sound judgment.

If a paving material possesses worth, the time has come when the public should know it; if unworthy in any way, the truth is worth more now than a season of repenting.

There are involved in the economy of a road: Its first cost; its use, and its up-keep. These elements of economy bear a close and distinct relation to each other. Each must sustain a harmony of relationship with all combined. The cost, therefore, must be commensurate with its use and its use must be sufficient to justify its up-keep. Its up-keep must be within bounds justifying its maintenance.

There are other elements in the matter of road economy that must be considered. The effect of the road itself upon abutting property, whether detrimental or injurious. The effect upon its users in a way that pertains to their comfort and pleasure.

Whether or not the time has come when the official charged with responsibility shall assert his professional judgment; whether the time has come when data that ought to constitute the basis of that judgment will be supplied and used both as to the grade quality of the improvement and the uses to which it may be subjected, is doubtless a question, because neither is done. Whether all pavements that are offered to the public are established in their proper economical place or not is exceedingly doubtful.

Aside from quality, aside from cost and maintenance, local supply of that which may be used is necessarily a matter to be considered and a feature that must affect very seriously the economy of any road improvements. Good judgment, therefore, will often select a road material by the weight of such consideration that otherwise would not be chosen.

The abstract actual cost, use and maintenance cannot be applied rigidly in all cases. The economy of any road material cannot and must not be judged alone. It must be understood that it is affected by the manner and method by which that material is used in the construction of the road. But the reasonable maximum worth which is only reached by the manner and method of construction may be and should be assumed, for the reason that there is no possible excuse for constructing a road out of any material that is at all worthy of consideration in any way except that way which will render a service approaching a maximum of its possibilities. We cannot fairly approach the subject of economy of any road material except on such assumption. It will, therefore, be necessary to understand something of what is required in manner and method of construction in order to properly understand its cost.

Cost of construction and cost of repair and all else is not the full measure of economy. But the greatest element affecting the economy of any road is, strange to say, the very one that is least taken into account, and that is its out-of-repair condition. That road that calls for the most frequent repairs is the road that is most likely to be out of repair, and it is the road that in the sum of lapses of time in which it is out of repair, aggregates a total detraction from the road's worth which by the lesser load hauled, the broken spring, the injured horse, the extra wear and tear of the vehicle, if converted into dollars, would often equal in a short period of time, the entire original cost of the improvement.

When a road is out of repair, the road investment is bearing no interest. The road as a whole is only as good as its worst portion—even the rule of average will not apply. On the other hand, by inverse ratio the road approaches its maximum worth as repairs are eliminated. The road, therefore, from which repairs are practically eliminated, is the real economic road, provided only that the traffic passing over it meets in a reasonable toll charge, the interest on its cost.

This leads to the proper differentiation as to the choice of the road and the amount of its cost. The expenditure for any road is justified so long as the amount of tonnage passing over it will aggregate a toll equal to a reasonable interest charge thereon. To the extent that it exceeds such a sum, it represents a profit to the user. I may inject that in both Canada and the United States poor roads exact a larger toll than good ones should or will if we ever reach a time when our roads are intelligently built.

This continued cry for maintenance is all right, so long as it is made in good faith, but the trouble lies in the fact that behind much of it stands the father of the suggestion whose interest urges the building of a road that will need continued repair.

If we properly understand how a block stone road should be constructed, in order to attain its highest efficiency and best service, we must accord it a place, perhaps the first place, as affording the best economy for roads and streets, subject to heaviest and most severe traffic.

It is regrettable that the elements of economy that are combined in a properly constructed stone block road are known to too few road builders, and when you begin to enumerate them, many a man will regard your assertions with suspicion. The writer recalls the shock with which his assertion was received by a well-known engineer to the effect that the noise resulting from the use of a properly constructed block stone road was much less than that which was common to roads of certain other materials. The lack of appreciation in this respect was entirely due to the fact that the engineer in question had had no experience with a properly constructed block stone road.

The place here given to a block stone road will not be supported by assertions or any detail of testimony.

*Extracts from paper read at First Canadian and International Good Roads Congress, Montreal, May [illegible], 1914.

This should be done primarily by the people commercially and particularly interested in block stone pavements, and it is surprising that so far as the general public is concerned, they—the block stone people—do not understand, at least they do not advocate the best use of their own product. This concession puts the use of stone block within somewhat narrow limits, while the use of vitrified brick is properly placed within the larger limits of the excessively used highways and important thoroughfares of the country. Such roads are to be found from points where travel converges and terminates at large centres of distribution. It also includes such roads as connect up centres of trade and population—in other words, the main market roads and thoroughfares of the country.

The original cost of a brick road is not necessarily excessive. The cost of grading, drainage, bridging and the entire preparation for placing thereon the artificial foundation and wearing surface, should be alike for all types and is, therefore, no more expensive for a brick road than is required for the least expensive type of wearing surface. This necessary preparation in the case of a brick road bears a feature of economy that is well worth while to mention. It is not readily injured, either from wear or tear or from any character of climatic influences. It is likely to remain intact. With the brick wearing surface placed upon it, ample protection for the durability of all the work incident to such preparation is afforded.

A curb for a brick highway is not necessary. A small upper lug built on the extreme edge of the concrete foundation, the height of the depth of the sand cushion, is all that is necessary.

The concrete foundation, if used, must be made entirely smooth, conforming to the grade of the finished street. Even a concrete foundation is not essential in case the subgrade contains much sand and gravel, enabling a complete, ready and perfect drainage. The ideal condition is a dry subbase. A concrete foundation, however, is advisable in most instances throughout Canada where we naturally expect a considerable season of low temperature. Over this foundation, whether of natural soil or concrete, must be placed a cushion of sand to a uniform depth from 1½ to 2 inches, thoroughly and evenly compressed upon which to place the brick. The interstices of the brick must be filled from the sand cushion full and flush with the top, a mixture applied as a fluid, of the best quality of Portland cement and fine sharp sand in proportion of one to one, the setting of which shall be protected from use, uneven temperature and destructive weather elements, until completely set.

THE PROGRESS OF THE ELECTRIC FURNACE.

It has been generally supposed that British smelters and refiners have shown considerable reluctance to adopt the electric furnace, but statistics go to show that after all they have not lagged very much behind other countries. There are now 14 electric furnaces at work in England, 13 in France, 20 in Italy, 17 in the United States and 32 in Germany, besides a few in other countries, making a total for the world of something between 140 and 150. A remarkable fact is that in Germany 50 per cent. of the furnaces are of the induction type and 50 per cent. of the arc type. Out of the 20 Italian furnaces 19 are arc, as are 10 out of the total 13 French, and 13 out of the 14 English. The Heroult, the Girod, and the Stassano are the arc furnaces most numerously adopted, while the Kjellin and the Röchling-Rodenhäuser occur most frequently in the induction installations. The progress in Scandinavia is shown by the fact that Norway and Sweden employed only nine furnaces for the smelting of pig iron in 1912, and had more than doubled the number by the end of the following year, when 20 furnaces were in full operation.

TAR TREATMENT OF ROADS.

The Road Board of Great Britain has issued a second edition of directions and specifications relating to the tar treatment of roads. In the specification for tar No. 1 (suitable for the surface tarring of roads), it is stated that the distillate between 170 deg. and 270 deg. C., or 338 deg. and 518 deg. F. (middle oils), shall remain clear and free from solid matter (crystals of naphthalene, etc.) when maintained at a temperature of 30 deg. C. for half an hour. It is, however, added that "this requirement may be waived in the case of tar supplied direct from gasworks; but tar from which the naphthalene has been extracted is preferable to tar containing much naphthalene." The tar must contain not less than 12 per cent. and not more than 21 per cent. by weight of free carbon. The free carbon is to be determined by complete extraction of the bituminous matter from a weighed portion of the tar by benzol and bisulphide of carbon. The residue left on treatment with these extractives is to be taken as "free carbon." Specification for tar No. 2 (suitable for making tar macadam, and for surface tarring in very hot weather, when the road crust is exceptionally dry) stipulates that the tar may contain not more than 25 per cent. of its volume of the tar (or distillates or pitch therefrom) produced in the manufacture of carburetted water gas. The free carbon limit, which was before put at 18 per cent. of the weight of the tar, has now been altered to not less than 12 per cent. and not more than 22 per cent. by weight. Prepared pitch from tar distilleries must contain not less than 16 per cent. and not more than 28 per cent. by weight of free carbon; and commercial soft pitch not less than 18 per cent. and not more than 31 per cent. In the latter case the pitch may contain not more than 25 per cent. of pitch derived from tar produced in the manufacture of carburetted water gas—in place of the 10 per cent. given previously. The last-named alteration has also been made in the case of tar oils.

TUNNEL THROUGH APENNINES NEAR COMPLETION.

The tunnel being constructed through the Apennines at a cost of $30,000,000 is nearing completion. When the Croce di Monaco tunnel through the Eastern Apennines is finished, the last engineering difficulty in the way of finishing the Puglian aqueduct will have been removed. The aqueduct was begun in October, 1899, and will, it is hoped, be completed next autumn. By diverting the River Sele, which flows into the Tyrrhenian Sea below the Gulf of Naples, its waters are carried through the main range of the Apennines to the Adriatic coast of Italy and delivered to the three arid provinces of Puglia. The aqueduct begins at Caposele, 1,358 feet above sea level, and the main waterway running to the eastern slope of the mountains at Venosa is 132½ miles long, of which 60 miles are cut through the rocky mountains. At Venosa the supply is divided into three conduits, one branch running to Foggia, another to Bari and the third to Lecee, in the very heel of Italy. These three main conduits have a total length of 1,000 miles; while the distribution among the principal towns and communes has necessitated the laying [illegible]

It has been decided after exhaustive tests to use Pretoria cement in the extensive harbor works at Cape Town and Durban. The output of the Pretoria cement works is about 1,000,000 bags per annum, and the company hold contracts both with the government and municipalities. Great care is exercised in the manufacture of the cement and recent tests gave the following results in tensile strength, after seven days 786 pounds, and after 28 days 931 pounds. It is anticipated that the local cement will ere long entirely replace the imported article in South Africa.

DISCUSSION ON "PRESENT DAY WATER FILTRATION PRACTICE."*

By John H. Gregory,
Consulting Engineer and Sanitary Expert, New York City.

THE author has presented a paper which contains much of interest to waterworks engineers and superintendents interested in filtration, and there is much in the paper with which the speaker is in hearty accord. There are, however, some phases of the subject on which the speaker holds somewhat different views from those of the author, among which may be mentioned the questions of the cost and difficulty of securing sites for slow sand filters and those of the cost of both slow and rapid sand filters.

The author states: "It is true, on account of the much greater area required, the cost for land is far greater in the case of slow sand filtration systems than for rapid sand systems. Roughly, other things being equal, land will cost twenty times as much for a slow sand filter installation as for a rapid sand plant." There is but little question that, under ordinary conditions, the cost of land for slow sand filters will exceed that for rapid sand filters, owing to the larger area required, but that it will amount to as much as "twenty times" as that for slow sand filters is open to question. Those who have had experience in acquiring land for waterworks projects know that, even if only a small piece of land is required on which to locate the works, but that this piece of land is a portion of a much larger tract, the purchaser might often as well buy the whole tract of land as to buy only a small portion of it. Thus it may readily be that, in acquiring a site for rapid sand filters, much more land would be actually purchased than needed simply for the plant. It may be that the area required for the construction of a slow sand filter plant will be twenty times that required for a rapid sand filter plant, but that the land will cost twenty times as much does not necessarily follow.

In discussing further the question of site the author states: "Furthermore, in large projects, it is often difficult conveniently to locate a site for slow sand filters, while for a rapid sand filter plant it is a relatively easy matter as a rule. If it is necessary to go a long distance in locating an extensive and suitable area of land for a slow sand filter site there is incurred a large expense for a conduit to bring the filtered water to the city." The inference might be drawn from this that it has been exceedingly difficult to secure sites for large slow sand filter plants, but the history of many of the plants which have been built will hardly bear out this inference.

In commenting on some of the plants which the author mentions (*The Canadian Engineer*, April 30th, 1914, page 666), the speaker might say that he has been personally connected with seven out of the fifteen plants mentioned, and is familiar with the reasons which led to the selections of the sites on which these works were built. It is, of course, necessary to have land on which to build filters, whether of the slow or rapid sand type, but in the selection of a site local conditions are often a very important factor.

* Mr. Johnson's paper, presented at the recent Convention of the American Waterworks Association in Philadelphia, was published in abstract form in *The Canadian Engineer* for April 30th, 1914. Mr. Gregory presented the discussion, given herewith, at the Convention on May 13th.

At Albany, N.Y., for example, practically the first ground available on which filters of either type could be built and which could be purchased at a reasonable price, was that on which the slow sand filters were actually built, just north of the city line. It happened that there was another tract of land a little nearer to the existing waterworks pumping station, to which the filtered water was to be delivered, where it would have been possible to build either slow or rapid sand filters. To have acquired land there, however, for either type of filters, would have been very expensive. The site on which the filters were built had another advantage in that the intake there would be further away from local sources of pollution. At Albany the Hudson River is tidal. The sewage from the city was and still is discharged into the river without treatment and on flood tides there is often an upstream current which carries some sewage with it. It will be seen then that other factors than simply area of land alone may have a bearing.

At Pittsburgh, Pa., as far as the speaker is aware, no difficulty was found in securing a site for the slow sand filters there, which plant is one of the largest in the world. The filter plant is located directly across the Allegheny River from the Brilliant Pumping Station, from which most of the water used in the city is pumped. It is true that it was necessary to build conduits under the river to bring the filtered water to the pumping station, but the case would have been the same if rapid filters had been built instead, for, if the speaker's memory is correct, the best site on which filters of either type could have been built was that on which the slow sand filters were constructed.

For the four slow sand filter plants in Philadelphia mentioned by the author, namely, Torresdale, Upper Roxborough, Lower Roxborough and Belmont, and of which the writer had charge of the design, no trouble was experienced in securing suitable sites.

As regards the Lower and Upper Roxborough filter plants, local conditions were of the greatest importance in that it was necessary to utilize existing reservoirs as settling basins, as well as existing pumping stations and pipe lines. Somewhat similar conditions existed with reference to the Belmont plant, although in this case there was no reservoir which could be utilized as a settling basin.

The Torresdale slow sand filter plant is the largest single plant in the world, and if difficulty had been experienced in securing suitable sites for such works it would naturally be expected to have occurred here. Such was not the case, however, and the plant was built inside the city limits. It is true that the plant was located some distance upstream from the closely built-up part of the city, and that a conduit about 2½ miles in length was constructed through which filtered water is delivered to the Lardner's Point pumping station, but it was good judgment on the part of the city authorities to locate the works where they did.

The Delaware River at Philadelphia is tidal and is polluted by the discharge of sewage from the city, and it was to avoid pollution as well as to secure a site that the plant was built as far upstream as it was. It might be added further that the city has already constructed a small sewage disposal works just below the Torresdale filter plant, where sewage is treated and the effluent disinfected before discharge into the river, in order to guard against raw sewage from the nearest point from reaching the intake of the Torresdale filters. Had rapid sand instead of slow sand filters been built at Torresdale there is no question in the speaker's mind but that such a plant

would have been built as far upstream as were the slow sand filters.

One might fancy possibly that trouble would be experienced by the City of New York in securing sites for filters. Such is not the case. Over ten years ago the Commission on Additional Water Supply, in its investigations for an additional water supply for New York City, looked into the question of filter sites not only for the additional supply, but also for the Croton supply. Sites were found where slow sand filters could be built in close proximity to the existing Croton Aqueduct, and sites for slow sand filters were also found and surveyed where the additional supply could be filtered along the line of the proposed new aqueduct. Some years later the Department of Water Supply actually prepared detailed plans for a slow sand filter plant for the Croton supply, on a site located in New York City, namely, in the east basin of Jerome Park Reservoir, the construction of which was suspended pending a decision as to the filtering of the supply. In the case of New York City it is not a question of going a long distance and building an expensive conduit to get a filter site, but rather a question of going a long distance and building an expensive conduit to get water.

At Cincinnati, Ohio, the rapid sand filter plant, which is the largest of its kind in operation in the world, was built well upstream above the city where plenty of land was available for either rapid or slow sand filters. The filtered water is discharged through a long conduit to a main pumping station from which it is pumped to the reservoirs in Eden Park. This plant was built for the future as well as for the present, and it was good judgment to locate the plant as far upstream as it was.

At Columbus, Ohio, the rapid sand filters were built at some little distance upstream above the city. It was a case here of going upstream to get out of the flood zone, although sufficient land for either rapid or slow sand filters was available nearer the city. At the point where the plant was finally built there was sufficient land for either rapid or slow sand filters. In acquiring the land for this particular plant it was found that it would be about as cheap to acquire the whole tract of land on which the works were built as to acquire only so much of the same as would be needed for the plant alone.

Perhaps enough has been said to point out that factors other than the area of land alone have to be taken into account, not only for slow as well as for rapid sand filters, in selecting a suitable site.

The author also considers, in the table on page 69, the cost of construction of different types of filters. It is exceedingly difficult to compare satisfactorily the costs of construction of different plants, even where the fullest information regarding the same is available. Those who are not well posted as to the history of some of the plants cited in the table may possibly be misled as to the cost of building both slow and rapid sand filters if they accept the figures of the author without full knowledge of local conditions.

One of the features which very materially affects the cost of such works is the total reservoir capacity provided, that is the combined capacity of the settling basins and of the clear water reservoirs. To illustrate: The rapid sand filter plant at Little Falls, N.J., which, in the author's table is the most expensive one cited, and which cost $15,000 per million gallons daily capacity, has a coagulating basin capacity of 1.3 hours and a filtered water reservoir capacity of 2.6 hours, or 3.9 hours total reservoir capacity. At Columbus, Ohio, the rapid sand filter plant there, which the author states cost $13,000 per million gallons daily capacity, the next to the highest in cost cited, has a settling basin capacity of 12 hours and a filtered water reservoir capacity of 8 hours, making a total reservoir capacity of 20 hours, or five times as much reservoir capacity as that of the Little Falls plant. If the reservoir capacity of the Little Falls plant had been approximately that of the Columbus plant the cost of construction of the Little Falls plant would have been materially increased over that given by the author. Again, the New Orleans rapid sand filter plant might be cited, which has 35.2 hours' total reservoir capacity, or practically nine times as much reservoir capacity as that of the Little Falls plant. Other factors which affect the cost of construction are the character of the raw water, the rate of filtration, the character of the construction of the works, etc.

In his reference to the Albany slow sand filter plant, the author gives its capacity as 20,000,000 gallons daily. The Albany plant as originally built before the pre-filters were added, had a capacity of 15,000,000 gallons daily. The addition of the pre-filters increased the capacity of the plant very materially so that at the present time the capacity is probably in the neighborhood of 28,000,000 gallons daily. If the capacity is taken at 28,000,000 instead of 20,000,000 gallons daily the cost of the plant would be about $14,300 instead of $20,000 per million gallons daily capacity, as given by the author.

The Philadelphia slow sand filter plants were expensive plants to build. They differ in one way from many of the other filters of the same type that have been built, in that underneath the filter floors and carried up all around the sides of the filters is a layer of puddle. This item alone materially increased the cost of construction. The Lower Roxborough and Upper Roxborough plants were built on high ground in an isolated section several miles from the nearest railroad, and the cost of delivering materials to such plants was higher than would ordinarily be the case.

In the cost of the Lower Roxborough plant the author did not include the cost of the Lower Roxborough reservoir, which was built many years before, and which supplies settled water to the filter plant. Again, a similar condition exists at the Upper Roxborough filter plant with regard to the settling basin. The New Roxborough reservoir was built some ten years earlier than the filter plant, and the author has not included its cost in the cost of the filter plant. Strictly speaking, the costs of the reservoirs should be included in the costs of these two plants so that the figures would be comparable with the costs of the other slow sand filters cited.

The Philadelphia plants were built during a regime of very high prices, and to use the costs of construction of these plants to indicate the reasonable cost of slow sand filters may be very misleading, except to those who are familiar with the early history of these works and who are aware that the costs were high and that the plants could be duplicated at less cost.

The largest slow sand filter plant under construction in America at the present time is at Montreal, and, when completed next year, will have a capacity of 60,000,000 U.S. gallons daily capacity. The total cost of the plant, on the basis of the lump sum contract prices, including the low lift pumping station, will be about $22,600 per million gallons daily capacity. Deducing the low lift pumping station, the cost will probably be about $21,000 per million gallons daily capacity.

It would have been interesting if the author had cited the cost of the slow sand filter plant which was completed at Toronto about two years ago. This plant has

a capacity of 48,000,000 U.S. gallons daily, assuming one-sixth of the filter area to be held in reserve, and based on a rate of filtration of 6,000,000 U.S. gallons per acre daily, the rate for which the plant was designed. The cost of the plant, omitting the low lift pumping station, was only about $12,700 per million gallons daily capacity.

In considering the weighted average cost of slow sand filters given by the author, namely, $32,600 per million gallons daily capacity, it may be well to bear in mind that the Montreal plant will cost only about $21,000, that the Albany plant cost about $14,300 and the Toronto plant only $12,700 per million gallons daily capacity.

In referring to the cost of rapid sand filter plants the author cites the Columbus plant as costing $13,000 per million gallons daily capacity. This plant was designed and built under the writer's direction and is a water-softening as well as a rapid sand filter plant. The cost of this plant was given in great detail in a paper* read by the speaker some years ago. The speaker is not informed as to what items the author included in arriving at the cost of the Columbus plant, but in the speaker's judgment the Columbus plant, considered as a rapid sand filter plant alone, cost nearer $15,000 than $13,000 per million gallons daily capacity, the figure given by the author.

Another rapid sand filter plant which the author might have cited is that of Toledo, Ohio, the cost of which was published in the Engineering Record, November 26, 1910. Part of the plant was built for a capacity of 60,000,000 gallons daily, although the present capacity of the works is considerably less. Including only such items as are chargeable to the filter plant proper, the works cost about $14,500 per million gallons daily capacity.

Another rapid sand filter plant which might have been cited is that at Grand Rapids, Mich. The plant was completed inside of the last two years and has a capacity of 20,000,000 gallons daily. The cost of the plant, as given to the speaker by the Grand Rapids officials last year, including such items as are chargeable to the filter plant proper, was $16,300 per million gallons daily capacity.

In December, 1912, the City of New York received bids for a rapid sand filter plant to be located at Jerome Park reservoir and having a capacity of 320,000,000 gallons daily. The speaker is more or less familiar with the plans for the proposed Jerome Park filters as he served as one of a commission of engineers appointed by the Board of Estimate of New York City to report on the same. Taking the lowest bid received and adding to it the cost of the building and other necessary work, the Jerome Park filter plant, which would have been the largest rapid sand filter plant in the world, would have cost about $18,400 per million gallons daily capacity. When the plant is built, and it is greatly to be hoped it will be built soon, the actual cost will probably be in the neighborhood of $20,000 per million gallons daily capacity, as much of the excavation for the plant has already been completed.

The author gives the cost of the Cincinnati rapid sand filter plant, which has a daily capacity of 112,000,000 gallons, as $11,400 per million gallons daily capacity, and states that the cost of the large, plain sedimentation basins is not included. At Cincinnati there are two large settling basins to which the raw water from the Ohio River is pumped. The water is first settled in these two basins, and is then delivered to the coagulating basins at the filter plant. There is no question in the speaker's mind but that the settling basins are part of the filter plant at Cincinnati, but just how much of the cost of the same should be chargeable to the filter plant may be a question. Mr. J. W. Ellms, the superintendent in charge of the filters at Cincinnati, in a paper printed in the Journal of the Association of Engineering Societies in January, 1912, states:

"The settling reservoirs, which have a capacity of 330,000,000 gallons of available water, are in part a portion of the water purification plant, although they also serve the purpose of storage basins and were designed for such a use quite as much as they were for sedimentation purposes."

The two settling basins cost $1,521,000, or about $13,600 per million gallons daily capacity of filter plant. Adding this cost to that of the filter plant would give a total cost of $25,000 per million gallons daily capacity. As the settling basins serve as storage reservoirs also, it may be reasonable to charge the filter plant with perhaps only half their cost. On this assumption the cost of the settling reservoirs chargeable to the filter plant would be $6,800 per million gallons daily capacity, thus making the total cost of the filter plant $18,200 per million gallons daily capacity.

Still another plant which the author might have cited, and among the best in the country, is that at New Orleans, which has a capacity of 40,000,000 gallons daily. Including only such items as are chargeable to the filter plant proper, the cost of the New Orleans plant was about $30,200 per million gallons daily capacity.

The weighted average cost of the Columbus, Toledo, Grand Rapids, Cincinnati and New Orleans rapid sand filter plants, is $18,600 per million gallons daily capacity, while the author gives a weighted average cost for rapid sand filters as $12,100. In other words, the weighted average cost of the five plants just cited, all of which are in operation and which are among the best in the country, is over 50 per cent. higher than the weighted average cost given by the author.

The speaker has but little further to say on the subject of cost except that, in his judgment, the weighted average costs as given by the author, are too high for slow sand filters and are too low for rapid sand filters. Similarly the fixed charges on the costs of construction would respectively be too high for slow sand and too low for rapid sand filters.

The speaker is not presenting any brief for slow sand filters. The rapid sand filter is more flexible than the slow sand filter and in the majority of cases in the United States is better adapted to the purification of water than is the slow sand filter. The slow sand filter has done and is still doing good work in this country, and the present status of water purification is, to a large extent, due to the introduction of the slow sand filter.

*Trans. Am. Soc. C.E., Vol. LXVII., 1910.

The Board of Railway Commissioners has recently issued a general order respecting an application of one of the railway companies to cover Circular No. [illegible], dated May 5th, 1914, whereby the railways were required to submit monthly, in duplicate, reports on fires originating within 300 feet of the track and burning off an area of [illegible] square feet or more outside the right of way. The applicant petitioned that the circular be treated as privileged and not open to the inspection of the public generally. The Board complied with their request, ordering that such reports shall be made public or given out upon application, and, therefore, only by its own order.

BRIDGE OVER NORTH THOMPSON RIVER, BRITISH COLUMBIA.

A FEW months ago a deck girder bridge 1,209 ft. in length with a girder lift span 93 ft. long and a height of lift equal to 53 ft. was completed for the Canadian Northern Railway Company over the North Thompson River at Kamloops, B.C. Approaches of timber trestle construction at both ends of the bridge have a total length of 1,123 ft. The fixed spans, 12 in number, correspond in length to the lift span, giving the whole structure a very well proportioned and balanced appearance. The lift span is second from the centre span of the structure, as shown in Fig. 1.

Fig. 1.—General View of the Thompson River Bridge.

The lift span weighs 118 tons and is operated by the assistance of counter weights attached to cables engaged in sheaves at the top of the towers, as shown in Fig. 2. The ends of the span ascend in guides so designed as to make due allowance for elongation due to changes of temperature and for changes in live loan. Cables, 1¼ in. in diameter, at each corner of the span pass over drums and are actuated through a system of gears by a gasoline engine, which, together with all the equipment, is located below the deck and between the girders in the centre of the span.

Fig. 2.—View of Lift Span, Showing Elevating Mechanism.

Centering castings provide for keeping the span in proper alignment when being seated. These castings also look after the longitudinal braking thrust. The track is equipped with the necessary special castings at the ends of the span to give continuity to the rails and with locks at each end of the bridge. Limit switches, coming into operation as the span is approaching its bearing, or its elevated position, control the igniter circuit of the engine which, under ordinary operating conditions, is capable of raising the span 53 ft. in 100 seconds, thus providing a clearance of 55 ft. above high water.

The bridge was designed by Messrs. Waddell and Harrington, consulting engineers, Kansas City, Mo. Mr. H. L. Johnston, divisional engineer for the C.N.R., represented the railway in its construction.

The approximate cost of the bridge was $250,000.

CANADIAN ELECTRICAL ASSOCIATION.

The twenty-fourth annual convention of the Canadian Electrical Association will be held in Montreal June 24, 25, 26 and 27, with headquarters at the Ritz Carlton Hotel. Local committees have been appointed and consist of the following:

General Committee—Major Hutcheson and Mr. J. S. Norris, joint chairmen; Messrs. L. D. McFarlane, E. F. Sise, G. H. Olney, R. S. Kelsch, R. J. Jones, J. M. Robertson and Dr. L. Herdt.

Ways and Means Committee—Mr. Julian C. Smith, chairman; Messrs. K. B. Thornton, J. A. Shaw, R. H. Balfour, W. F. Graves and R. F. Morkill.

Entertainment Committee—Mr. Lawford Grant, chairman; Alderman Boyd, Messrs. Paul Sise, R. G. Harris, W. C. Lancaster, W. H. Winter, H. C. Post, P. Roper, Powell and R. M. Wilson.

Publicity Committee—Mr. S. W. Smith, chairman; Messrs. W. J. Doherty and L. J. Belnap.

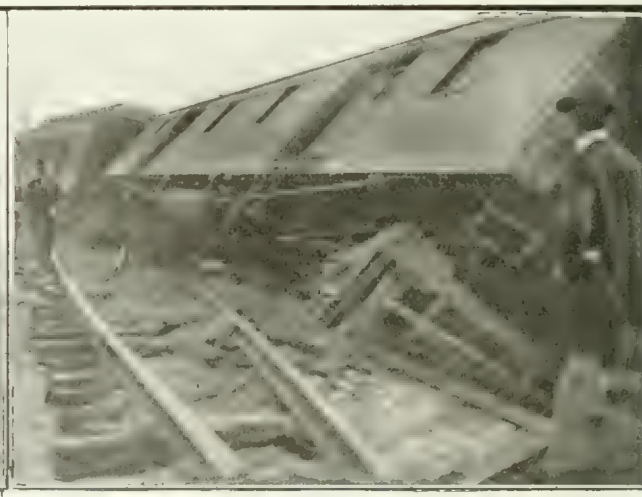
Finance Committee—Mr. J. W. Pilcher, chairman; C. F. Medbury, F. W. Smith, R. M. Wilson and L. B. Belnap.

P. T. Davies, honorary secretary.

A special programme has been prepared by the Entertainment Committee which is sure to appeal to all visitors. Special souvenirs have been provided for the ladies.

RECENT DERAILMENT NEAR TROUT CREEK, ONTARIO.

THE accompanying views give rise to some interesting conjectures in connection with train derailment. The accident which they illustrate occurred to the "Cobalt Special" at four-thirty in the morning. One of the Pullmans contained a party of railroad engineers, one of whom was looking out the window at the time, and it was stated positively that the speed at the moment of derailment did not exceed fifteen miles per hour. The extraordinary manner in which the rails, ties and ballast were torn out indicates the seriousness of such an accident occurring at this point at high or even moderate speed.



Views of Recent Derailment Near Trout Creek, Ont.

Apparently, one truck of one of the forward cars mounted the west rail, and after travelling along the ties for perhaps forty feet, commenced the process of tearing things loose. The following cars, on reaching the damaged roadbed, left the rails and completed the destruction. The point at which the rail was mounted was clearly indicated, though the gauge at this point and for some distance to the south was quite correct, and showed no reason for the derailment. When the train came to a stop, the tender and six out of the eight cars were off, some of which needed but little more to roll them completely over. One of the photos indicates three lengths of rail, detached from the ties and quite free from fish plates and bolts, apparently lying close to their original positions and not in any degree twisted or otherwise damaged.

We are indebted to Mr. K. L. Aitken, consulting engineer, Toronto, for the photos illustrating the mishap.

CONCRETE ARCH BRIDGES.

The following conclusions drawn in a paper, "Concrete Bridges; Some Important Features of Their Design," by Walter M. Smith, Sr., and Walter M. Smith, Jr., in Vol. 39, p. 1193, Proceedings of the American Society of Civil Engineers, are of interest. This paper deals with the advantages of an arch of two ribs over the solid soffit arch, with narrow ribs rather than wide ribs and with deep ribs of I-section rather than rectangular section; it also deals with the advantages of the three-hinged arch over the fixed and two-hinged types.

The writers believe that the following conclusions are amply justified by the investigations:

(1) An arch span consisting of two separate ribs is more economical than one with a solid soffit, if the span is greater than 100 ft.

(2) Narrow, deep ribs are more economical than thin, wide ones.

(3) The three-hinged arch is more economical and reliable than fixed or two-hinged arches for spans greater than 100 ft.

(4) For spans of 200 ft. or more the rib of I-section is more economical than the rectangular rib.

(5) Piers of any considerable height are much more economical if built of two separate legs thoroughly braced, thickening rapidly in the direction of the axis of the bridge as they go down.

On June 2 the steel mills of the American Steel and Tinplate Company, which have been idle for many weeks, were ordered into service again; and nine of the eleven mills began running. The other two are being repaired.

A plan is under way and is being furthered by the Baden government, Germany, to dredge and widen the Rhine River from Strassburg to Constanz; and the project is declared to be a perfectly feasible one. The dredging and widening of the river portion from Strassburg to Basle, would, it is considered, be an integral part of the main waterway from Strassburg to Constanz; and the Rhine should be made navigable to Constanz or not at all. For Baden, the undertaking is one of great importance as it would eventually open up a waterway for the largest steamers from the North Sea to the Baden Sea.

Coast to Coast

Woodstock, Ont.—Estimates for the year 1914, totalling $83,082.81, have been approved by the London city council.

Sarnia, Ont.—The Dominion Government has commenced dredging along the docks of the Northern Navigation Company at Point Edward.

Windsor, Ont.—Niagara power will be delivered in Windsor by August 1. All the towers are placed, and installing of equipment is progressing rapidly.

Hamilton, Ont.—Another offer has been made to the city of Hamilton of property to be purchased for a civic stone quarry. The firm of Teeter & Kemp offer 110 acres in the township of Saltfleet for $30,000.

Ottawa, Ont.—The city council of Ottawa has adopted a motion calling for the appointment of a committee to inquire into the existing organization regarding the construction and maintenance of roads, and to bring in a report.

Swift Current, Sask.—No further drilling will be done at the Swift Current gas well until October 1. Collarless pipe must be secured from Germany before the contractors can carry the depth of the drill to 3,000 feet, as recently decided upon by the city.

Oil Springs, Ont.—It is stated that the new Oil Springs oil and gas strike on the Wallen property is now estimated at a capacity of 12,000,000 feet per day, and this in consideration of the fact that drilling has only been carried a couple of inches into gas rock.

Weyburn, Sask.—A recent discovery was made a few miles south of Weyburn of an extensive quarry of what is claimed to be excellent sandstone. The deposit is located one mile from the C.P.R. station at Ralph, and shows a seam about 8 feet thick and 50 feet wide.

Toronto, Ont.—City Surveyor Le May has outlined a scheme for the remodelling of North Toronto, which is now being considered by civic authorities. The project calls for the extension of many streets and the opening of others, which will reach an expenditure of about $1,000,000.

Vancouver, B.C.—Paving work at Vancouver, recently contracted for by the Canadian Mineral Rubber Company, is progressing rapidly. Within a few weeks, a total yardage of approximately 16,000 square yards has been completed, and the company is now busy at the resurfacing of Vancouver street.

Winnipeg, Man.—Work is reported as showing satisfactory progress on the power plant of the Winnipeg Electric Railway Company being built at Grand Bonnet Falls. In April a private railway along the company's right-of-way was commenced, and is being rapidly built. It will extend 12 miles from Lac du Bonnet to the power site.

Sudbury, Ont.—The construction of the Sudbury-Copper Cliff Suburban Electric Railway has been commenced, and it is the intention of the company to have the line completed this year from Sudbury to Copper Cliff. Three lines are contemplated at present, e.g., Copper Cliff route, 5.1 miles; Ramsay Lake route, 1.2 miles; and Frood Mine route, 1.2 miles.

Toronto, Ont.—The works committee of Toronto has recommended to council submission of money by-laws amounting to $1,734,465, as follows: roadway section, asphalt plant, $125,000; sewer section, $121,400; Dundas street bridges, $148,000; North Toronto water supply mains, $525,000; extension of high-pressure system, $500,000; other mains, $315,000.

Vancouver, B.C.—City officials of Vancouver observed recently tests of pressure made at the First Narrows on the water main recently connected between the north and south shores, which have been reported as very satisfactory. It is stated, also, that the work of hauling across the second 18-inch main, which is to form one of the connections for the Point Grey partnership pipe line, will commence at once.

Ottawa, Ont.—The compromise reached in connection with the question of the liability of the government in guaranteeing the bonds necessary to complete the construction of the G.T.P. mountain line, provides that the government shall guarantee bonds for three-quarters of the additional cost required for completion. It is understood that the amount of the guarantees, including interest, is $16,000,000.

Edmonton, Alta.—It is claimed by experts who have spent years north of Edmonton that oil fields will be developed to the north of the province which will prove to be of much greater moment than those in south-western Alberta now attracting world-wide attention. The country is said, by geologists, to show both surface and geological indications of the greatest oil development.

Ottawa, Ont.—The city auditor of Ottawa has reported to the city council that the total cost so far of the work on the old intake pipe is $153,849.37, as given in a statement prepared by the city engineer's office. Of that amount, already there has been passed $122,708.45, of which $82,636.63 has been for extras. The city engineer's estimate for the entire work was only $57,000, and the contract was let to Loomis, McBean and Williams for $40,000.

Victoria, B.C.—An inspection was made recently by D. O. Lewis, divisional superintendent of the C.N.P. railroad, particular attention being made to Section D, which lies between mileage 100 and 140. The grade from mileage 124 to 135, which runs through heavy rock work, has been practically completed. It is said that this section of the road is in splendid condition, requiring but little more attention at the hands of the contractors. Nothing has been done, of course, between mileage 136 and 140, where there are alternative routes between which a choice has yet to be made.

London, Ont.—Actual construction work undertaken this year by the city engineer's department under by-laws passed by the council now totals $525,000, a small amount of this having been authorized last year. The road work being carried out in the city is well under way. The concrete work on Horton street from Ridout street bridge has been completed, and the work of laying vitrified brick surface can now be undertaken. Work on the Wharncliffe road sewer has been commenced and will be completed, it is expected, within two weeks; after which the laying of pavements will proceed.

Victoria, B.C.—The laying of concrete flow line along the route between Humpback reservoir and Cooper's Cove in connection with the Sooke Lake water supply works, is reported to commence shortly. Enough pipe is ready to proceed with work on this section as well as on the line from Sooke Lake to Cooper's Cove, where work is in progress. Also for the section of the pressure line between the reservoir and the city, the fabricating of steel pipe will soon be commenced by the Burrard Engineering Company. Preparations are being made for procedure on excavation for the line, continuing on from the point where excavation now stops.

Fort William, Ont.—Owing to the fact that, upon breaking through many of the pavements in Fort William, it is found that the earth has sunken below them, leaving no support whatever, a new system of street paving is being advanced by M. Ferguson and J. H. Walker, of west Fort William. Their plan is to construct a line of concrete piers under the crown of a pavement and to run a reinforced con-

crete beam over the top of these as a support to the pavement. If, as in the case of some of the city roads, the sewer is laid in the centre of the street, they propose that two rows of piers be constructed, one row on each side of the sewer. With such a system, it is said, the pavement would carry the greatest loads even when the supporting earth sinks away beneath it.

Brandon, Man.—In an address made to the Brandon Trades and Labor council upon the power question, Mayor Hughes advocates as the most feasible and profitable way of getting power for Brandon the hydro-electric scheme from the Winnipeg river. In support of his contention, Mr. Hughes gave the following figures for the cost of power from Winnipeg: cost of line from Portage to Brandon, $297,903, this to include transformers, patrol and upkeep of the line, $5,500 per annum; one-half cost of line from Portage to Winnipeg, $12,630; 2,500 h.p. at $20, $50,000, making a total of $91,386 for power and upkeep of line. Speaking of the probable income, the speaker said that from the waterworks $20,000 would be realized; from the street railway, $12,000; and from the street lighting, $18,000. These sums were in addition to revenue from two flour mills, the C.P.R., C.N.R., and numerous smaller plants.

Vancouver, B.C.—A recent report on the construction of C.P.R. bridges over the Pitt and Harrison rivers in British Columbia says that structural operations are now well advanced on the double-track bridge being erected by the C.P.R. over the Pitt River. The huge swing span, 276 feet in length, and weighing 650 tons, is being erected; and girders are being placed from the eastern end of the structure. Nearly one-third of the upper portion of the bridge has been erected; and the work is expected to be completed in November. The structure is 1,750 feet in length, and will be the largest of its kind on the British Columbia division of the C.P.R. Also rapid progress is being made on the Harrison River bridge, a structure of a similar type to the Pitt River bridge, and 950 feet long. The superstructure is nearing completion, the swing span having been installed and work well advanced from both ends. It will be ready for service, it is anticipated, by the end of July.

Brantford, Ont.—The Board of Water Commissioners has awarded contracts for a new waterworks pumping plant. Two De Laval 12-inch, multi-stage, centrifugal pumps, two De Laval single-stage, double suction type booster pumps, and two high-speed turbines for driving the booster pumps, will be supplied by the Turbine Equipment Company, Toronto. The contract for the 250 h.p. synchronous motors for driving the domestic pumps has been awarded to the Canadian Westinghouse Company, Hamilton. The output of each of the domestic units will be 4,000,000 imperial gallons per day, against 200 feet head. The output of each of the booster units will be 4,000,000 gallons, against 100 feet head. In case of the electrical power being out of commission, the two booster pumps can be arranged to run in series, the output being 4,000,000 gallons against approximately 90 pounds pressure. In case of fire, either booster pump can run in series with either electrically-driven domestic pump.

Ottawa, Ont.—The city council of Ottawa has passed the first reading of by-laws authorizing the issue of debentures totalling about $1,000,000, which include the following amounts for local improvements: $44,239.33 for sewers; $164,846.84 for asphalt pavements; $10,206.23 for opening of Murray street; $14,385.41 for opening of Heney street; $93,530.53 for asphalt pavements; $14,008 for tarvia pavements; $98,571.91 for concrete sidewalks; $159.50 for plank sidewalks. Other items of expenditure are: $5,000 to complete main drain system; $5,000 to pay city's share of cost of subway on Bank street; $8,000 to pay for cost of alterations and additions to Howick hall; $50,000 for construction of horticultural and agricultural hall; $30,000 for completion of main drainage system along certain streets; $25,000 for trunk sewer in Rideau ward; $80,000 for bridge over canal; $60,000 for cost of intercepting sewer through Broad street yard of C.P.R.; $40,000 for new hydrants and water meters; $80,000 for water mains and extensions.

Sault Ste. Marie, Ont.—According to a judgment made public at Ottawa on June 4 by the International Joint Commission in the case of the Michigan Northern Power Company and the Algoma Steel Corporation, these companies are to be allowed to divert 30,000 cubic feet of water per second from the river; and this means the development by Sault Ste. Marie of 106,000 continuous electrical h.p. The capital cost of the development will be $13,250,000. Throughout the consideration of the case the paramount rights of navigation interests have been kept in mind; and the powers given the companies are contingent upon the construction of a dyke so operated under Government supervision as to ensure the maintenance of the level of Lake Superior. Under the lease by the United States Government to the Michigan Power Company the dyke and sluice-gates on the American side will eventually be acquired by the United States Government, and similar action will probably be taken by the Canadian Government in respect to the works on its side of the river.

Toronto, Ont.—The plans for the Don section of the Bloor Street viaduct, as designed by Engineers Thomas Taylor and C. W. Power, of the Civic Works Department, show a straight stretch of construction from Castle Frank road east to the present western terminus of Danforth avenue, with a high bridge of 4-arch span crossing the Don Valley and river, the longest span to be 282 feet from pier to pier. The deck of the viaduct is divided longitudinally into three sections, the two outward sections being devised for street traffic, the central section for rail. A ballasted roadbed is planned to deaden the noise customary in connection with traffic bridges. Moreover, provision is made in the plans for providing a lower deck to the viaduct in future to accomodate rapid transit railways; and whenever the growth of street traffic warrants, it will be possible with little alteration and expense to remove all the cars from the upper deck and to provide a clear roadway from one side of the viaduct to the other. Preparation of plans for the Rosedale section of the viaduct are almost completed. This section comprises two diagonal stretches from Sherbourne and Bloor Street south-east to the head of Parliament Street produced, and thence north-east to Castle Frank road.

Vancouver, B.C.—Besides the Central Park section of the trunk sewer to be constructed by the Greater Vancouver joint sewerage commission, and for which tenders are to be advertised shortly, there are many other portions of work, some of which are also included in the 1914 program outlined by the commission. Sections which are in a fair way to being realized are the Clark drive interceptor, which will take all the sewage from China Creek to Burrard Inlet; extensions to the present Bridge street sewer, the construction of that along Balaclava street, and the laying of a trunk line east of Hastings Park, extending from the inlet some distance south of Hastings street; the Stanley Park interceptor, which will do away with the outfall at English Bay and will carry all sewage from the West End into the First narrows; and the deepening of the Brunette river, which will lower Burnaby lake and allow of better drainage of the surface water in the section of Burnaby municipality in this vicinity. The China Creek trunk sewer and its tributary, the Canoe Creek extension, are now in progress; and the city is preparing to lay lateral sewers draining into the trunks, which will serve D.L. 301, hitherto without sewers of any kind. Up to the present, at least $200,000 has been expended on the work.

OIL ENGINES FOR FISHERIES.

The attention of Canadian manufacturers of oil engines suitable for fishing craft, is drawn to the increasing demand in Great Britain, by the report of Mr. J. E. Ray, Canadian trade commissioner at Birmingham. There seems to be a very keen competition in the supplying of oil engines for this purpose as all types of British fishing boats are being equipped with motors as auxiliary power. The leading British manufacturers of heavy type paraffin and hot-bulb engines are said to be extremely busy. A well-known firm in England secured in one week recently fourteen orders for paraffin motors of 55 and 75 b.h.p. to be installed in boats on the coast of Scotland.

The outfitting of these boats with motor power has had a remarkable growth during the last few years. Nearly all the new intermediate boats and yawls on the east coast of England have motors. Fishing craft, large and small, along the Irish coast and at the Isle of Man ports are also being fitted. The same applies to the south of England, to the Shetlands and to the west of Scotland. Scarcely a new boat is being turned out in which a motor is not installed.

PERSONALS.

WM. FORBES has been appointed road superintendent for the County of Oxford, Ont.

A. M. JACKSON, of Brantford, has recently been appointed engineer to the County of Brant.

GEO. B. TAYLOR was recently appointed superintendent of the power and water departments of the city of Medicine Hat, Alta.

E. R. SMITHRIM, B.A.Sc., has been engaged by the Public Utilities Commission of Strathroy, Ont., to superintend the construction of its distribution system for Hydro-electric power.

C. G. DAVEY, a 3rd year student in mechanical engineering at the University of Toronto, has been awarded the scholarship of the Boiler Inspection and Insurance Company of Canada.

CHAS. W. POWER, assistant engineer, City of Toronto, in charge of the Department of Railways and Bridges has resigned and on July 1st, will become associated with the Canadian Stewart Company, Toronto, as engineer in charge of harbor work.

CARL WEBER, the inventor of the Weber reinforced concrete chimney, has become president of the Gun-Crete Company of Chicago. The firm specializes in cement-gun work for engineering, mining and industrial structures, and is also introducing the Weber system of hollow concrete floor construction. These floors are erected without forms and are said to be sound, fire and water proof and of light construction.

At the University of Toronto commencement exercises held on June 5th, the professional degree of civil engineer of the University of Toronto was conferred upon Messrs. P. Gillespie, associate professor of applied mechanics; C. R. Young, assistant professor in structural engineering; T. H. Hogg, assistant hydraulic engineer, Ontario Hydro-Electric Power Commission, and S. N. Hill, Topographical Surveys Branch, Department of the Interior, Ottawa.

The degree of electrical engineer was conferred upon R. A. Sara, sales manager, Winnipeg Light and Power Department.

OBITUARY.

On June 1st, Mr. Chas, C. Nugent, of Toronto, was fatally injured in a motorcycle accident. Mr. Nugent was 35 years of age and a native of Ireland. Since his arrival in Canada seven years ago he has been engaged in civil engineering work, during which time he has been connected with the Toronto staff of the Canadian Pacific Railway.

The death was announced on June 2nd, of Mr. Wm. R. Perrin of Chicago, architect, engineer and contractor for the Toronto civic abattoir. Mr. Perrin was 54 years of age and was head of the firm of W. R. Perrin and Company, Chicago and Toronto.

In the list of those who met death in the disaster which befell the Empress of Ireland is included the name of Mr. A. E. Barlow whose activities in mining and geological work throughout the Dominion are widely known. Mr. Barlow was for many years connected with the Geological Survey of Canada. During another period of his career he held a professorship in McGill University, Montreal. For some years prior to his death he has been engaged in private practice as consulting engineer and geologist. Only recently Mr. Barlow made some extensive investigations in British Columbia in connection with which he took passage to England on the ill-fated liner.

On June 5th death came accidentally to Mr. Rob't. H. Jupp, engineer for Simcoe County, Ont. Mr. Jupp was inspecting the construction of a bridge at Nicolston when he fell a considerable distance as a result of a misstep.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eight Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chausse, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21885—May 27—Approving location C.N.R. proposed third-class station at Marvin, Saskatchewan.

21886—May 27—Approving location C.N.O.R. station grounds at Clemow, Tp. Barron, Dist. Nipissing, Ont., mileage 133.26 from Ottawa.

21887—May 20—Rescinding Order No. 21217, dated Jan. 16th, 1914. And directing that Can. Nor. Que. Ry. fence portion of its right-of-way between mileage 26 and 27, on south side of track, on or before June 1st, 1914.

21888—May 26—Authorizing, temporarily, pending installation of interlocking plant to be called at crossing, Toronto and Eastern Ry. Co., to operate trains over crossing of G.T.R. Port Perry Branch at Town of Whitby, Ont., for construction purposes only; interlocking plant to be installed on or before July 20th, 1914. All movements of Applicant's trains be flagged over crossing by an employee of Applicant Company.

21889—May 27—Dismissing complaint of Mrs. Kate S. Massiah, Lachute, Que., alleging discrimination by C.P.R. against Lachute, in issuing commutation tickets to St. Agathe, Vaudreuil, Hudson, and other points.

21890—May 27—Authorizing C.P.R. to construct road diversion in S. W. ¼ Sec. 3-8-29, W. 2 M., Sask., and construct, by grade crossing, its Weyburn-Stirling Branch Line across said road allowance between S. W. ¼ Sec. 3 and S. E. ¼ Sec. 4-8-29, W. 2 M., mileage 105.23, on said Branch Line.

General Order No. 125—May 30—Directing that terms of Judgment, which is hereby made part of this Order, and tariff changes therein directed to be made, be complied with and become effective not later than Sept 1st, 1914; and that, for period of two years from date of this Order, no rates at present in effect west of Port Arthur, Ont., be increased without approval of Board.

21891—May 27—Authorizing C.P.R. to construct siding for I. L. Lafleur, town of Notre Dame de Grace, from point on southerly limit of right-of-way of main line, Eastern Div., mileage 2.54, Windsor Street, to Montreal Jct., in Lot Cadastral Nos. 181-23, 24 and 25, (Civic) Notre Dame de Grace Ward, city of Montreal, Mun. of Parish of Montreal, Co. Hochelaga, Que.

21892—May 27—Authorizing C.N.R. to construct across and divert highway between Secs. 15 and 16-11-22, W. 2 M., at Traux, Sask.

21893—May 26—Authorizing C.N.O.R. to construct, by means of a separation of grades, across G.T. and C.P.R. Cos., in city of Toronto, Ont.

21894—May 27—Amending Order No. 21508, dated March 14th, 1914, to allow G.T.P. Ry. to make certain changes in highway crossings in Tp. 34, Rgs. 1 and 2, W. 3 M., Sask.; and extending for period of 30 days from 31st May, 1914, time within which said work required under Order No. 21508 was to be completed.

21895—May 27—Authorizing G.T.P. Ry. to construct spur for Inland Lumber and Building Co., Ltd., Edmonton, Dist. North Alta., Alberta.

21896—May 26—Authorizing G.T.P. Ry. to construct highway crossing over its main line in N.W. ¼ Sec. 7-53-4, W. 5 M., mileage 44.9, Sunset Ave., Whitewood Sands, Alta.

21897—May 27—Authorizing G.T.R. to construct siding and spurs therefrom, into premises of Elias Rogers Co., Limited, leased from G.T.R., city of Toronto, Ont.

21898—May 27—Authorizing G.T.R. to construct siding into premises of United Drug Co., Limited, city of Toronto, Ontario.

21899—May [illegible]—Authorizing G.T.R. to use and occupy branch line authorized to be constructed by T., H. & B. Ry. to lands of National Steel Car Co., Limited, under Order No. 17562, with full right and power to run trains over and upon said spur, subject to any Orders or directions Board may hereafter make as to exercise, enjoyment, or restrictions of powers and privileges herein granted, and subject to and upon certain conditions.

21900—May 27—Directing that Dominion Atlantic Ry. employ flagman to protect crossing of highway west of Port William Station, N.S., when trains are passing Port William Station without stopping.

21901—May 28—Amending Order No. 21243, dated Jan. 21st, 1914, by striking out word and figures "Fifty ($50.00)" in last line of Order and substituting therefor "Ten ($10.00)."

21902—May 29—Approving agreement entered into between Bell Telephone Co. and Byron Telephone Co., and dated May 14th, 1914.

21903—May 29—Approving agreement entered into between Bell Telephone Co. and Alnwick Rural Telephone Co., Limited, dated May 15th, 1914.

21904—May 29—Directing C.P.R. construct subway under tracks crossing highway between lots 5 and 6, Con. 5, Tp. Toronto, Ont., proposed subway be constructed in line with highway so there will be clear view through it from highway at each end; headway, 14 ft.; clear span of 20 ft. over crown of highway. Cost of construction, 20 per cent., not exceeding $5,000, by railway. Grade-Crossing Fund, 5 per cent., remainder by village of Streetsville, 15 per cent. Tp. Toronto, and 80 per cent. by Ry. Co. Surface of road be maintained by Municipal authorities responsible for highway; all other cost of maintenance be borne and paid by Railway Company.

21905—May 28—Dismissing application Town Aylmer, Que., for reduction in fare between Ottawa and Aylmer on Hull Electric Railway.

21906—May 29—Refusing application St. Mary's Horse Shoe Quarry, St. Mary's, Ont., for Order relieving it from expense of maintenance and interest charged upon G.T.R. spur into their property.

21907—May 28—Directing Lake Erie and Northern Ry., at own expense, to construct level crossing over railway where it crosses farm of Bradford Bowlby in Lot 5, Con. 2, Tp. Woodhouse, Ontario.

General Order No. 126—May 28—Declaring that report or reports submitted by Railway Companies in accordance with Circular No. 133, are privileged, and shall only be made public or given out upon application therefor by Order of the Board.

21908—June 1—Amending Order No. 21837, May 18th, 1914, by adding after figures "589" in 3rd line of recital to Order words and figures, "and No. 1186, certified copies," and striking out words "a certified copy"; and striking out word "condition" and word "Order" in 1st and 2nd lines of operative part of Order and substituting word "conditions" and word "Orders."

21909—June 1—Extending, until August 15th, 1914, time within which G.T.R. complete work of lighting Victoria Bridge, Montreal.

21910—June 1—Relieving G.T.R. from providing further protection at crossing of railway immediately west of Lorne Park Station, Ontario.

21911—June 1—Amending Order No. 21725, April 29th, 1914, by striking out following words and figures: "the said crossing to be constructed in accordance with Standard Regulations of Board Affecting Highway Crossings as amended May 4th, 1910," in last three lines of operative part of Order.

21912—May 27—Authorizing C.P.R. to construct diversion of Graham Ave., town of Stonewall, Man.; authorizing Co. to construct, by grade crossing, its main line, Man. Div. Arborg Sub. Div. across Lilly St., said town of Stonewall.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

THE MODERN METHOD OF SEWER VENTILATION

OUTLINE OF ESSENTIAL FEATURES OF THE MOST POPULAR SYSTEM—IMPORTANT CONSIDERATIONS TO GOVERN STORM AND DRY WEATHER FLOW.

By DR. ERWIN KOHLMANN, Dr.-Ing.; Dipl.-Ing.

THE modern method of sewer ventilation consists of numerous openings to the sewers from the atmosphere. This system has met with great success in Germany and in the United States of America, as it promotes an ample circulation of fresh air in the sewers.

This system is the direct opposite of that in which the circulation of air or the ventilation is promoted by using, artificially, individual factors as motive powers for the process, as it favors the co-operation of all the factors which have any influence on ventilation by a continual motion in all parts of the sewerage system through numerous openings, and the resulting continuous circulation of air tends to restrict the formation of obnoxious gases.

If the sewerage system is properly designed and constructed with grades sufficient to ensure a self-cleansing velocity, the sewage will always be in a fresh condition, and thus the generation of gases would be reduced to a minimum, for in spite of the best designed systems there will be, to a certain extent, a small deposit of sewage adhering to the walls of the sewers caused by the constant fluctuation of the flow and with it the generation of gas, but by proper ventilation this danger is overcome, as the oxygen contained in the atmosphere destroys all substances adhering to the walls or otherwise deposited in the sewers by oxidation, thus by the strong dilution of the sewer air with the fresh air the nuisances caused by sewer gases are avoided.

This system of ventilation consists of the installation of two groups of connections between the sewer and the atmosphere, the one at the lowest possible point (such as the openings in manhole covers) and the other at the highest possible point (such as the rain water and soil pipes on houses). The differences in the levels of inlet (the lowest point) and outlet (the highest point) form the main movement of the current of air.

First we will consider the high level group. If the down pipes are connected directly to the sewer, that is without any trap, there would be created a series of highly located connections with the atmosphere, which, in combination with the manhole orifices, would present favorable conditions for the forming of such a considerable difference in levels. To produce an upward current in the down pipes, it is necessary to have a source of heat so that the air in these pipes would exceed the temperature of the atmosphere. In cold weather the source of heat is promoted from heated buildings, and a very small excess of temperature is necessary to promote a velocity sufficient to influence the process of ventilation. Even in winter the co-operation of these down pipes can be relied on for the circulation. In summer the conditions are much more favorable, as are also those times during the action of the sun's rays.

This system of ventilation is much more efficient in streets which are located east and west, and the efficiency extends annually to 2216.2 hours or 25% of the year.

In times of storm, the upward current is eliminated. This condition has often been cited against the use of down pipes for the purpose of the ventilation of public sewers, but when it is considered that the rain duration is only 518 hours annually, or 6% of the total, and the sewers during rain are cleansed by the indraught of air, there is no reason why this should be considered seriously, especially when we consider that this system requires no artificial assistance and, therefore, no expense. However, in residential districts, or in houses where the attics are used for dwelling purposes, it is not advisable to use the down pipes for the purposes of ventilation, so that only the soil pipes could be used.

The pipes most suited for ventilation are those in proximity to the furnace or kitchen chimneys, as the surroundings during the whole of the year have a heat exceeding that of the sewer air, and correctly, soil pipes have been termed the "natural chimneys of ventilation."

The temperature always being higher in the soil pipes causes the motion of the air, and if these pipes were extended to a height above the roof, either of the same or larger diameter, they would form a perfect means of maintaining the continuous current of air from the manhole inlets through the sewers into the atmosphere, and even in times of storm their efficiency is not impaired if a protecting cowl is provided to prevent the admission of rain or air attracted by rain. (Fig. 1.) In draughty locations, the efficiency of these pipes as a means of ventilation may be increased by providing a revolving cowl, but if this is provided, provision must also be made to protect the house traps from their seal being broken, which is done by secondary ventilating pipes. Experiments were made in Cologne by Dr. Unna* with the revolving cowl without protection to the house traps, when it was found that the seal was broken.

In reference to the irregularity of the direction of the current, this is governed by local conditions. Frequently there are special conduits for sinks and bath waste which also partake in the process of ventilation. If these are

*Gesundheits-Ing., 1898, 21 Jahrg., No. 4 and No. 5.

located some distance away from any source of heat or on exterior walls, as is found in conveniences which are placed in a shed or outhouse, a downward motion takes place by which the efficiency is lessened and the ventilating influence on the sewer is reduced considerably. Since the efficiency of house drains is greatest if all pipes are placed in a warm location, provision should be made in local by-laws compelling owners of houses to continue the soil pipe to a sufficient height above the roof, and in the case of new buildings the soil pipes should be placed as close as possible to a chimney. In this manner the irregularity caused by the house drains in cold locations would be overcome, and more house connections would co-operate in the removal of the sewer air. The greater the suction, and the more house connections there are, the better would be the condition of the sewer air.

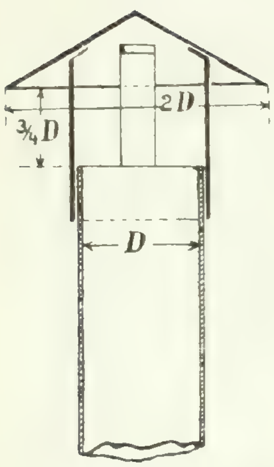


Fig. 1.—Cowl for Soil Pipe.

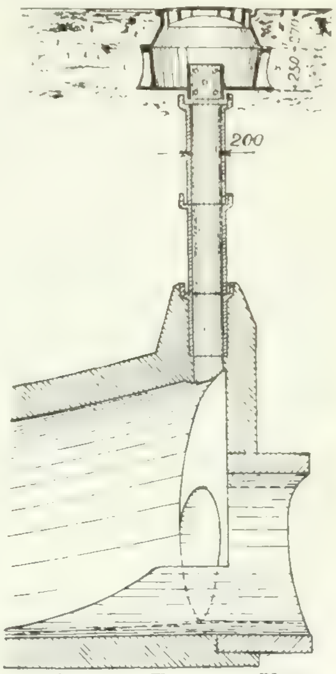


Fig. 2.—Type of Vent Shaft.

It might be mentioned here, that occasionally a downward current of air is caused by waste water from sinks and baths, but this discharge is generally of such short duration that the matter is not worth considering. On the other hand, if the question is raised against the downward current, it should always be borne in mind that a reversion of direction helps to flush the house drains thoroughly, and owing to the large number of remaining house drains it does not interfere with the general process of ventilation and is, therefore, desirable. If the ventilating efficiency of the soil pipes is irregular, the reason can generally be found in the absence of, or defective, air inlet.

We will now consider the second group, viz., the connections between the sewer and the atmosphere at the street level. These air inlets consist principally of perforated manhole covers. The distance separating these covers should range, in small sewers, from ninety to one hundred and fifty feet, and in large sewers from one hundred and eighty feet to three hundred and thirty feet. If the distances are greater than this, the addition of a special shaft would be necessary.

Under normal conditions, in dry weather, a continuous circulation from the manholes through the sewer to the houses takes place and the constant current will only be occasionally interrupted, as stated above. In times of storm, these conditions would be different. On a shower of rain entering a sewer an energetic air current is caused, which has a reverse direction to that during dry weather. A large volume of air is attracted through the down pipes by the accelerated falling velocity of the rain, and is conveyed into the sewers. The mixture of air and water fills the sewer, causing air tension.

Since the house connections, in time of rain, are soon submerged, the air cannot escape from the sewer through these drains, it will, therefore, try to find its way through the sewer to the street gullies. It cannot escape through these gullies owing to the quantity of surface water discharging from them. If the seal in the trap of the gulley is sufficient to resist the air pressure the escape of sewer air is prevented, and thus the only exit would be through the perforated manhole covers. If these covers are not perforated the air cannot escape and the sewers will become air-bound, so that the gullies will not be able to discharge into them, thus causing the streets to become flooded, and the pressure of air in the sewer would still be increasing until the manhole covers are forced and the joints of the sewer blown, causing considerable damage.*

In spite of the provision of perforated manhole covers flooding may still occur unless care is taken to have a sufficient number of manholes and their covers provided with an adequate number of perforations such that they will not be ventilating covers in name only. Many proposals have been previously made on account of the former unreliability to use only the perforated manhole covers or only the house connections for the ventilation of the sewers, but all these have been rejected. No group *per se* could be both inlet and outlet. On the other hand, heavy showers displace the sewer air by completely filling the cross-sections of the sewers, thus promoting circulation as well as in dry weather the differences in levels and temperature. We would not abstract from considering showers as favorable for the ventilation, but it would be better to improve the existing defects so that all trouble which may occur during storms will be avoided. An installation often resorted to is the provision of vent shafts similar to those shown in Figs. 2 and 3. Although these vent pipes are most essential during periods of rain, they also materially assist the circulation during dry weather.

These vent shafts serve two purposes, viz., to assist the manhole inlets when these are a considerable distance apart and to act as outlets for sewer air during heavy rains, when the house connections to the sewer are submerged. Thus, the installation of these vent shafts is recommended as an auxiliary means to promote thorough ventilation.

Since the connections of the sewer with the atmosphere at street level have serious disadvantages in some cases such as the danger to traffic caused by the holes in the manhole covers, the difficulty of cleaning and keeping the holes in the cover open, which is of vital importance for circulation, attempts have been made to substitute the perforated manhole covers by providing air inlets from the sidewalks or by the gullies.

The first method, that of inlets from the sidewalks, would scarcely answer the purpose, apart from the initial cost, as the maintenance would be a prohibitive expense, if adequate circulation is to be constantly maintained, on

*[NOTE.—An illustration of such an occurrence was reported in the Toronto daily press following a severe rainstorm on June 7th last. The pressure became so great in the Garrison Creek sewer that a section 20 feet in length was blown out; flooding Willowvale Park, it is announced, to a depth of 3 feet, with water and sewage.—Editor.]

account of the amount of silt and dirt collected in the pits. Another reason is the complication of the construction of these inlets which is not adaptable to the simplicity which should always be attempted to attain in ventilation and sewerage systems.

The second method is that of using the gullies. The theory is advanced that there are a greater number of gullies on a street than there are manholes, and the perforations of the manhole covers are not nearly the area of the openings in the gulley grating, and that these perforations, if not properly made, are liable to become clogged. This method has its advantages, as in dry weather there would be a greater number of air inlets, but it is questionable whether the gulley as a vent outlet in times of heavy rain accomplishes its purpose. The opinion of the author is that larger quantities of air are attracted by the discharge of the gullies rather than allowing the

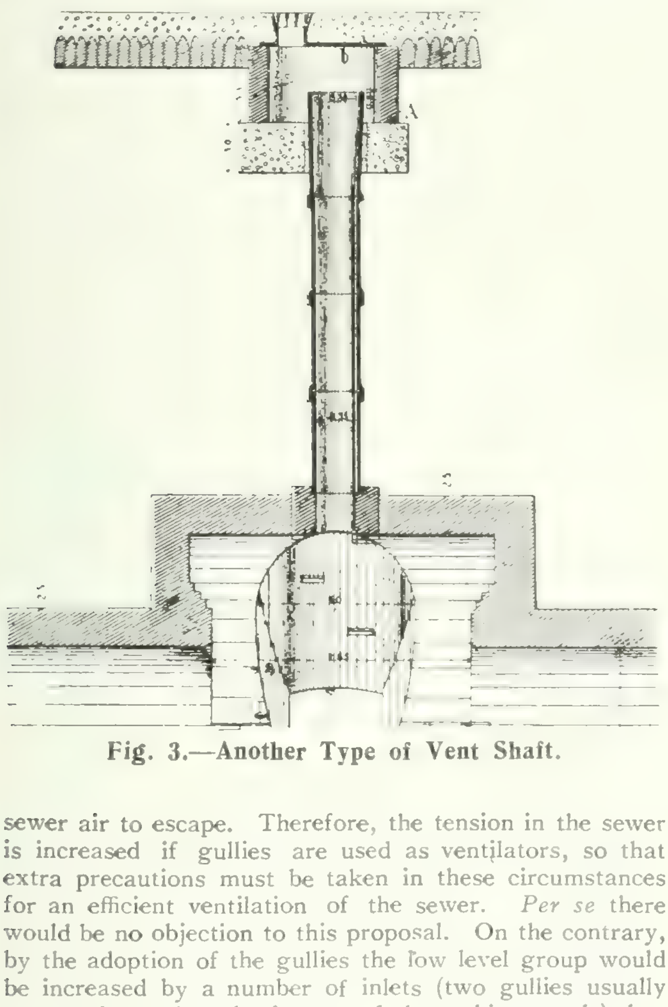


Fig. 3.—Another Type of Vent Shaft.

sewer air to escape. Therefore, the tension in the sewer is increased if gullies are used as ventilators, so that extra precautions must be taken in these circumstances for an efficient ventilation of the sewer. *Per se* there would be no objection to this proposal. On the contrary, by the adoption of the gullies the low level group would be increased by a number of inlets (two gullies usually arranged on a length of street of about thirty yards) thus presenting a double number of low level connections by which, in dry weather, a better circulation would result. It is doubtful, however, if the gulley as a vent outlet during times of storms accomplishes its purpose owing to the house connections being submerged. In the opinion of the author, large air quantities are rather attracted by the discharge of the gullies and the tension of the sewer air is, therefore, increased. If the gullies are used as ventilators, special precautions must be taken for an efficient ventilation of the sewers in these times. This takes us back to the adoption of perforated manhole covers, where in times of rain the displaced sewer air will collect, and by which during the dry weather the renewal, even of the upper air strata, is best obtained.

As already mentioned, the connection of the sewer with the atmosphere at the street level has two disadvantages, the ascending of sewer air during heavy rains, and the danger of the holes in manhole covers to the horses. An emanation of sewer air, however, in a well-ventilated sewer takes place only if the same is filling rapidly. Objection to by-passers cannot occur by this, as a well-ventilated, well-flushed, and above all a properly designed and constructed sewer contains only fresh and no decomposed sewage, and thus no foul air.

It is of absolute importance that the orifices in the manholes should be made small enough to reduce the danger caused by the horses catching the studs of their shoes in the holes. It is a mistake to replace covers with large openings by covers with small ones, as is sometimes done, which are even then ineffective as they become clogged by silt. The author is of the opinion that the manhole covers are the cheapest and most suitable means for low level ventilating orifices, and these openings can be brought into practical form by due consideration. By the suitable selection of orifices in arrangement and construction, accidents would be decreased, but to eliminate them would be practically impossible even with the most approved style of covers. According to an investigation conducted by Herrn Falkenroth with the covers of various designs, he proves that the danger to horses is decreased by the use of large openings and the proper construction of the ventilating orifices. The requirements of an ample air circulation in dry weather and unhindered removal during storms are fulfilled likewise by large openings, which are not so liable to become clogged.

The long segmental, oblong, square, radiated orifices cannot be considered, due to the danger to horses. After Falkenroth's experiments, the manhole covers with circular openings proved to be the most satisfactory. The openings in all cases should be inverted conical so that stones and silt could then fall to the receiving tray placed under the cover, and the selection of sufficiently wide circular orifices (1½-in. or more) will also exclude, or at least restrict to a minimum, the number of cases of traffic troubles or accidents. Simultaneously with the correct choice the requirements of an ample circulation will be fulfilled. Cities that have replaced the former covers with covers having circular openings have succeeded by this innovation, and the openings have met the requirements in reference to favorable circulation, safety to traffic and cleanliness. (See Fig. 4.)

Whilst the most suitable form of ventilation known may be adopted, it cannot be said that the sewer ventilation problem has been solved. In spite of the circular openings it may be necessary to consider the possibility of occasional sewer tension during storms. The great draught in the upward direction retards the adequate air escape. The quick run-off of the sewage requires the installation of sufficient and uniformly distributed openings for the expulsion of the air. Since sewer ventilators are fewer than house drains, comparatively, the ventilating conditions would be much more favorable if a means was found in another group of low level connections to assist the ventilating orifices of the manhole covers during time of storms. This assistance may be obtained by the cooperation of street gullies. The gullies are at present generally constructed in such a manner that the silt washed away by precipitation is retained in special receptacles, and the gullies are trapped from the sewer. This construction has two great disadvantages, viz., the nuisance of foul odors and the danger of silting up. The receptacles of the street gullies, and to a certain extent the house gullies, on hot days and days of atmospherical

fluctuations form a source of malignant odors. The deposits washed off by precipitation, consisting principally of paper, rags, street sweepings, fallen leaves, etc., mostly of an organic nature, undergo decomposition during their retention, often lasting for months, and thus pollute the air in the streets. A still more serious danger is caused by the traps. The light matter passing the gulley grating is not naturally retained, but frequently chokes the trap. Catch pits and water traps should be rejected in any case, even if cleaning takes place frequently. Firstly, the removal of the collected silt is neither

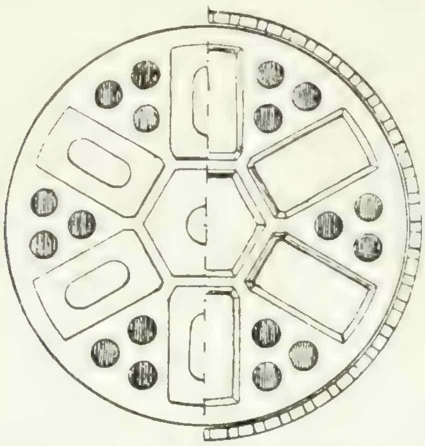


Fig. 4.—Manhole Cover With Circular Perforators (by Falkenroth).

hygienic nor æsthetic, and secondly, the silt retained in the receptacles will decompose and eventually infect the freshly entering flow, which will reach the sewer in a strongly contaminated state. With proper ventilation and flushing arrangements, however, in a sewer with sufficient grade, it would not lead to odorous nuisances, thus there is no necessity for a trap.

Simplicity should be the standard of a sewerage system, also the protection against odors of any kind. Therefore, the catch pits and traps should be discarded. It should always be the endeavor to prevent obstacles in design so as to remove the sewage, in fresh condition, as quickly as possible without any objection to the senses of sight and smell, from any dwellings. For this reason the water trap between the sewer and house drains has been rejected as unsuitable and the catch pits in the manholes abolished, as both have been the cause of a direct offence to inhabitants. Why is this measure not extended to the catch basins of the gullies and down-pipes? Why pin our faith to catch basins and traps in gullies, while close beside them manholes are built without catch pits, and their covers are, without any objection, equipped with ventilating perforations? The contradiction to this condition should be the best argument for the abolition of catch pits and traps. As soon as the catch pits are omitted no silt will be retained which would cause nuisances, and when the traps have been abolished there will be no more choking of gullies. Above all, an exceedingly favorable opportunity for a constant ventilation would be acquired. Indeed, in recent times prominent sanitary engineers were always advancing the advisability of the correct recognition of these advantages for the abolition of the gullies in the present form. Indeed, in recent times prominent sanitary engineers were always advancing the advisability of the correct recognition of these advantages for the abolition of the gullies in the present form. Prof. Ewald Genzmer advanced this desirability in the sewerage of the city of Schwetz (Fig. 5) which was designed by the author, and so did Stadtbaurat Fleck at Dresden. On the other hand, it will always be those who doubt the economy of such an enterprise who will speak against the generalization of the measure adopted in Schwetz. Such views can be discarded if we consider the figures. Generally one meets with the view that the quantity of silt retained by the catch pit would result, if omitted, in considerable additional cost for the cleaning of sewers. A calculation made by the author based on the annual report and the budget of the city of Dresden may lead to this aim.

According to the annual administration report of this city for 1911, the gullies in paved and macadam roads were cleaned in the recorded time, four times a year, in asphalt and wood-paved roads, sixteen times, on account of the bigger amount of silt conveyed into the gullies of the latter by precipitation and the more frequent washing. The catch basins of the down-pipes were cleaned only once a year.

The street gullies contained, on an average, 1/25 to 1/30 cu. yd. of silt, while that from the house gullies was only .07 to 0.11 cu. ft. The total silt removed was 4154.21 cu. yd. and the cost amounted to $5,250.

Frequently the washing of a street suffices to fill the gulley completely, so the catch basin or the tray in the basin will not be able to contain the larger quantity of silt which is washed away at times of precipitation. The silt, moreover, passes directly into the sewer where it is carried away by the sewage flow, or by flushing. The cost for the removal of street silt is, to the greatest extent, generally included in the cost for the cleaning of sewers, and only the smaller part comes into consideration for the cleaning of the gullies.

On investigation as to whether the sewers are able to withdraw the silt retained in the gullies or whether by its artificial removal by means of flushing, additional cost would ensue. Figuring on a water consumption of

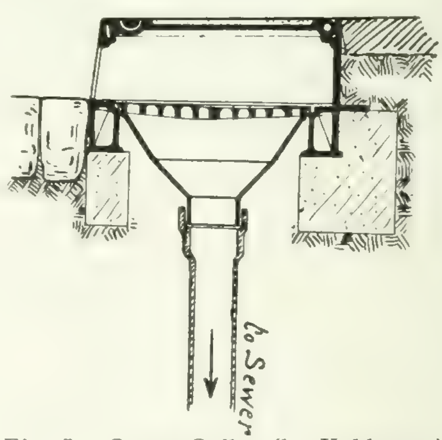


Fig. 5.—Street Gulley (by Kohlmann).

$120 l = 4.24$ cu. ft. per capita per day, it would mean for a population of 550,000 3,139,200 cu. yd. sewage per annum. The annual quantity to be removed from the gullies, however, only amounts to 4154.21 cu. yd. or 1.32 per M. of the D.W.F. (dry weather flow). Considering, further, a solubility of silt matter of 36%, the silt quantity would be able to be reduced to .085 per M. of the D.W.F. This small amount would doubtless be removed without any extra cost for haulage expenses by the uniformly flowing current of the D.W.F.

The conditions during times of storm are quite different. It is generally believed that the increased velocity, and larger flow in the sewers would have a greater clear-

ing capacity. This is not the case. By practice it is shown that during a storm the greatest deposits will occur in the sewer. It was found by the author that the rainstorm of July 10th, 1912, deposited in a trunk sewer on the Terrassenufer at Dresden, a quantity of grit of 52.32 cu. yd., while under normal conditions the weekly flushing operation removes only 2.6 to 5.2 cu. yd. of grit in the same sewer.

Since through the lower parts of the sewerage system, in consequence of abolition of the catch pits, large quantities of silt will pass, there is a danger that in times of storm a greater deposit of silt will take place. The reason is that in times of storm only the suspended matter is attracted, which is taken into eddies, the remaining silt is deposited especially where the velocities vary considerably. The additional cost which the cleaning of the sewers involves would by no means be so great as that required for the cleaning of gullies. According to Herrn Kajet, the cost of cleaning gullies amounts to 30% to 40% of the total cost of cleaning sewers.

There is another reason for the abolition of the catch basins. It has often been stated that it is more rational to remove the silt from the gullies instead of the sewers, as they are more accessable. However, if it is considered that the periodical removal of quantities of silt from the gullies (in some cases weeks elapse before they are cleaned) can be executed only with difficulty and with a certain amount of nuisance, a method would be preferable by which the removal of street sweepings is obtained hygienically and æsthetically unobjectionable condition which is inevitable in the most perfect design of cleansing implements. This advantage offers the odorless and invisible removal of the street sweepings by the sewers. By this method a further advantage is obtained, viz., that the quantity of silt containing organic and mineral matter which is soluble up to 64% on its way, according to the time in which it remains in the sewer, is considerably reduced until eventually in the grit chamber at the sewage disposal plant a complete separation of the organic matter is affected, that is, the separation of the sludge proper from the mineral constituents, the heavier suspended matter. If the cross-section of the grit chamber is designed in such a manner that the velocity is never less than one foot per second, so the grit will settle while the putrescible sludge passes into the settling tanks with the fresh sewage without being affected whatsoever.

As the removal of the detritus in the grit chamber is effected principally by machinery, the result is of further economic advantages to this system, indeed a disposal plant will have, by the collection of the soluble and suspended constituents of the street sweepings, an overcharge, but the cost for cleaning would not be materially increased as the amount of soluble and suspended matter is only 36%, and but .085 per M. of the dry weather flow. Applying this to the Dresden conditions means that in the most favorable case, instead of 4154.12 cu. yd. of street sweepings which are carried into the sewer, only 2659.16 cu. yd. of mineral matter will settle in the detritus chamber. The cost of removal of 1 cu. yd. of silt amounts, in the Dresden-Neustadt plant, to about 38 cents, including the wages of men and maintenance of the dredge, while the cost for cleaning the gullies amounts to $1.34 per cu. yd. This example may suffice to dispose of the objections of those who have doubt in the economy of the method to convey the street sweepings directly into the sewers.

If, however, in some special cases, such as mountainous districts or asphalt and macadam roads, larger collections of sand are carried off by the quantities precipitated, and find access into the gullies it may be advisable to arrange small catch basins. In cases of paved roads, however, the arrangement of catch pits must be designated as absolutely obsolete. Together with the catch pits, there would obviate the last installations which would cause the pollution of the air, and thus the air of public sewers and of all connecting pipes to these would lose their offensive odor and character. With the abolition of traps indeed we have gained a further series of low level connections which effect at least as much as the perforated manhole covers and the co-operation of which for the ventilating process, in reference to the overweight of the domestic soil and down-pipes compared with the vent openings at street level restricted by the limited number of manholes, is of an importance which should not be underestimated. Indeed, we had to make certain alterations in construction in order to use the gullies for continuous ventilation.

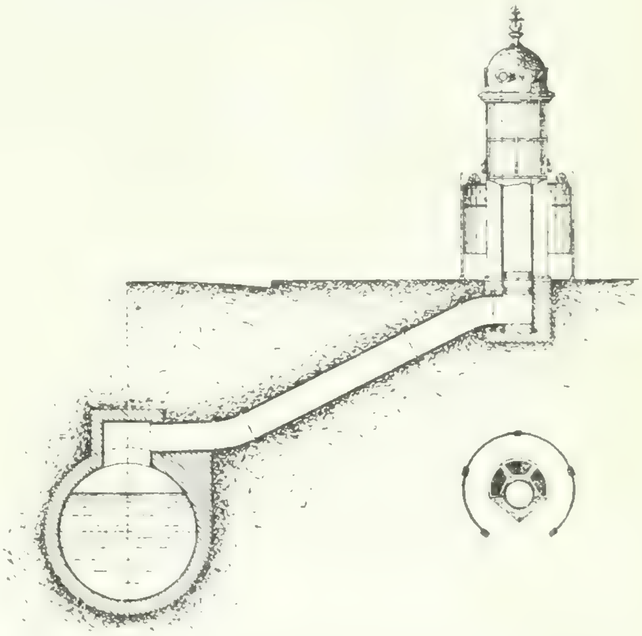


Fig. 6.—Ventilating Device on a Paris Trunk Sewer.

Gullies are generally adopted with cast iron gratings, either parallel or rectangular to the curb line. One may be of different opinion as to the advantage or disadvantage of both kinds. While it has been observed that in some cities gratings with bars parallel to the curb permit a better passage for floating matter, such as pieces of wood, paper, leaves, etc., other cities prefer, for the same reason, gratings with rectangular bars. With regard to the safety of traffic, both designs are not approved. On one side it is stated that horses with their studded shoes have been caught in gratings of the second style and damage resulted therefrom, while the opponents maintain the same gratings of the first design. In both cases the cause is probably to be found in the unsuitable construction of the gratings, too narrow slits, or their unfavorable location in the gutter. In any case, a well-designed grating has proved itself to be a rain inlet in flat streets. With the correct location in the gutter, gratings with sufficiently wide openings and rounded-off corners, which prevent the catching of studded shoes of horses, will fulfil all requirements in regard to safety both of run-off and to traffic.

Regarding the ventilation, it is more difficult to obtain sufficient results with this construction. With gratings, the experience has been found that in times of storm the large quantities of rain running off and extending over

the grating, in consequence of the collected floating matter, does not permit the air trapped in the gulley to escape. To overcome this difficulty, the area of the grating should be increased by which the desired results can be obtained. The process performed thus is that the upper part of the grating collects the water and the lower will allow the escape of sewer air. An increase in the grating cannot always be obtained, especially in narrow business streets or steep roads, where the horses are equipped with heavy shoes and long studs; alternations in the design of these gratings have to be made. In steep roads where gratings do not answer the purpose, on

Fig. 7.—Superstructure for Ventilating a Trunk Sewer in Dresden. (The dome is equipped with self-recording rain gauges.)

account of the high velocity of the surface water and especially if the surface water contains much floating matter, it runs over the grating and the expensive and difficult installations of pre-grates have to be adopted so as to prevent the flooding of the streets in the lower districts. In these hilly districts gullies with side entrances have been successfully adopted. The side inlet gulley comprises all the advantages to the safety of run-off and of traffic, as well as ventilation. It carries away all floating matter and particles liable to clog the ordinary grating, and at the same time there is no danger to horses. With this installation the circulation of air in the sewerage system will always remain normal, as in times of storm its inlet is never wholly covered, thus the escape of air is not hampered. For these reasons the side inlet gulley is preferable and the adoption of gratings should only be permitted temporarily as is done in Schwetz, where broad streets with very little traffic are equipped with gratings.

It frequently happens that larger foreign-matters are placed malignantly into the side entrance gullies by which the choking of the inlet takes place, which would otherwise be kept clear by the increased clearing power of the water rushing down. The removal of these matters can only be performed with difficulty and at considerable expense. The author considers it advisable to provide a funnel-shaped inlet with a movable grate, the openings of which are so arranged that only such matter is retained by which a choking of the drain is liable. By this method the ventilation would not be impaired.

By omitting the traps in the gullies the advantage is secured of the prevention of tension in the sewer air which is produced by the air adhering to the water in times of heavy precipitation. Even if the surface water discharged by the gullies contains atmospheric air, the ventilating orifices in the manhole covers will be relieved. As in times of storm, large quantities of air enter the sewer, attempts have been made to separate the mixture of air and water by what is known as air separators contained in bends or orifices in the down-pipes or special vent pipes in the down-pipes, but these attempts should not be considered on account of the dangers which may arise by the interruption of the duties required by the down-pipes.

Probably a better means for the conveyance of the air attracted through the down-pipes is by the use of the domestic soil pipes. It is a general practice in a combined system to convey the storm and sanitary flow by a common conduit to the sewer. Thus there would be no reason, in a combined sewerage system, to construct the house drainage on the separate system. With regard to the ventilation, however, there would be objections, and a separate introduction of storm and soil pipes from domestic premises into the sewers would be desired as well as in combined systems. We have already recognized the soil-pipes as the material means for sewer ventilation during dry weather as they are able to maintain by their higher temperature a constant current of air in the direction from the sewer to the atmosphere. It does not seem advisable to exclude these uniformly acting factors from the ventilating process during times of storm and to connect them with pipes which do not act air-ejecting as those do, but air-forcing. By the accelerated falling velocity, the down-pipes convey, during times of storm, quantities of air and water with such intensity that it cannot be of any effect to the soil-pipes on the sewer. If it is further considered that in dry weather the connection of both pipe systems in a common conduit promotes independent currents by the difference in the temperature prevailing between the down-pipes and soil-pipes, which results always in a trouble of the aspiring efficiency of the house connections on the sewer. The author thinks it advisable to introduce down- and soil-pipes as separate conduits. This would show that during dry weather the influence of the soil-pipe on the removal of the sewer air is greater than by the separation of the down-pipes and the trouble in the operation on the ventilating process would thus be eliminated.

During times of storm the sewers are quickly filled so that the house connections, the mouth of which are placed just above the level of the dry weather flow in the sewers, are soon submerged. It might be proposed to effect the introduction of the house drains at the top of the sewer. Thus, the ventilation of the sewerage system by means of the soil pipes would in any case separate again the quantities of air introduced by the down-pipes, and no tension in the sewer would occur.

If the introduction of the house drains at the dry weather flow level was placed so as not to be offensive to the workmen in the sewer by the discharge of domestic sewage, there would be no objection to the carrying out of this proposition for the inaccessible sewers, and as the exceedingly greater number of conduits in each sewerage system consists of inaccessible sewers there would be maintained in this greater part of the system an ample

circulation and during times of storm the air quantities introduced by the roof water would easily be removed. With this construction no special auxiliary means, such as vent shafts, would be required. In larger sewers this proposal can scarcely be effected. Here also, a possibly high introduction of house drains would be desired. A higher location of the mouth in height of the springing line could not be attained as already in normal conditions in larger sewers complaints of offences become numerous

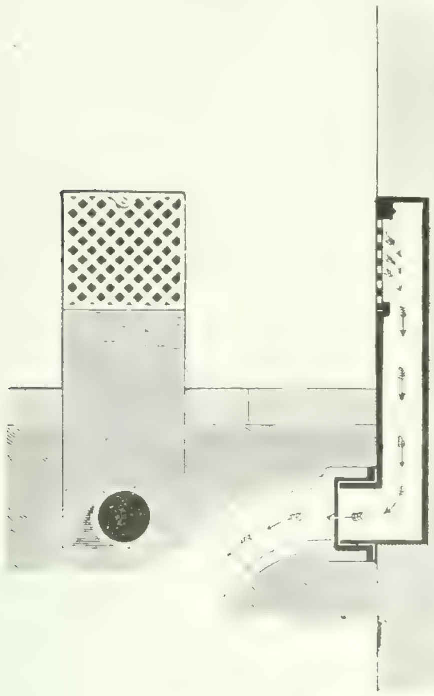


Fig. 8.—Air Inlets.

by the workmen in consequence of the splashing of sewage. Thus in big sewers where the distance between the manholes is greater, the adoption of vent shafts must be introduced.

Every sewerage system has further series of subterranean structures not to be avoided, such as side entrances or shafts with stairs. At these points the air would reach, under circumstances, abnormal tensions. On the other hand, these chambers will flood during times of storm and will be covered with sludge so that in such cases sufficient ventilation should be provided. These should be located at the highest points, as a nuisance to passers-by and neighbors may arise. They should also be equipped with special vent pipes which lead to suitable places in the atmosphere. In Paris, for instance, this is done by the use of the numerous public urinals, and in Dresden special superstructures have been erected over special entrances. (Figs. 6 and 7.) In some cities the efficiency of these vent pipes has been increased by artificial means, and in Brunswick gas stoves were used until recently in the trunk sewer vents. Leipzig used two electric fans to increase the suction through the vents, while in Magdeburg the aspiring ability of houses and high chimneys for the removal of the sewer air has been effective, similar to the ventilating efficiency of the soil pipes. In low-lying districts where manhole covers are air-tight, generally on account of floodings which occur, other means of ventilation must be adopted. In order to effect the circulation by two groups at different levels, a number of inlets have to be installed in lieu of air-tight manhole covers which could be designed in such a manner as is used in England. (Fig. 8.) The removal of the sewer air will then be performed by the soil pipes, or if this is insufficient an additional number of special vent pipes have to be provided.

The question as to the most efficient system of the ventilation of public sewers can therefore be answered thus: By constantly keeping a circulation of air in the sewers during the time of dry weather flow, thus preventing development of gases, and at time of storm to eliminate air tension. Therefore, there must be a constant circulation during dry weather from the perforated manhole and street gullies, without a trap, through the sewer to the soil pipes placed in a warm location and carried above the roof, and in times of rain an air current must be possible in the reverse direction from the down pipes to the manholes. The gullies without a trap and the soil pipes have to perform the separation of the attracted atmospheric air.

In such a manner it would be possible to remove the sewage from houses and premises without creating a nuisance or source of danger to the health of the community by the sewer air, and thus the modern system, that of numerous openings to the air, will have reached the highest degree of perfection.

DRAINING OF KERR LAKE.

An interesting feature of 1913 mining development operations in the Cobalt district was the draining of Kerr Lake in order to make available the ore in the immediate lake bottom, and also to allow prospecting under the lake to be carried on with greater safety. The following notes on these draining operations at Kerr Lake during the summer and autumn of 1913 have been supplied by Mr. Robert Livermore, manager of the Kerr Lake Mine, and appear in the recent report of the Temiskaming and Northern Ontario Railway, prepared by Mr. Arthur A. Cole, Mining Engineer to the Commission:—

After the granting of permission in May, by the Mining Commissioner to dewater Kerr Lake, work was taken in hand at once. All preliminary surveys had been made some time previously, defining the route for the water via a 20-in. pipe line directly from Kerr to Giroux Lake, crossing the Kerr Lake property over the height of land between the two lakes. The greatest elevation of the line above water level of Kerr Lake is 53 feet, the linear distance from lake to lake 2,400 feet, and the difference in elevation between the two lakes 20 feet.

Kerr Lake at this time covered an area of 30 acres, of which 18 belonged to the Crown Reserve, 6 to Kerr Lake, and 6 to the former Drummond Mine. The purchase of the latter acreage by the Crown Reserve and Kerr Lake Companies jointly included the total area of Kerr Lake under the ownership of the latter companies, by whom the entire operation was jointly undertaken and managed. Soundings made of Kerr Lake during the previous winter had established the fact that there were approximately 400,000,000 gallons of water and semi-liquid mud. Giroux Lake covers some 230 acres, and is of great depth, with a large outlet flowing to the Montreal River, so that by using the direct route instead of via Kerr Lake outlet and Glen Lake, to Giroux as at first proposed, there was no possibility of flooding other properties.

On account of the necessity of pumping a certain amount of mud together with the water in order to clear the bottom of the lake sufficiently for mining purposes, and on account of the changing level of Kerr Lake, and the consequent increase of head against which this material must be pumped, a pumping plant capable of

great flexibility, not only in the nature of the material to be handled, and efficiency against a varying head, but also in changeability of base, had to be designed. This plant as finally installed consisted of four single-stage centrifugal pumps, arranged in two units. Each unit made a compound pumping outfit of two pumps, arranged one on each end of the base, with a direct-coupled motor between the two. The pump shells were 1½ in. thick, with removable side discs, the runners being of the enclosed type, capable of handling solids up to 4 in. in diameter. Each unit was designed to deliver not less than 3,000 gal. per min. at the highest elevation to be encountered. At the start the four pumps were to work in parallel, each discharging its own stream into the main pipe through specially cast fittings. When the head became so great that the best efficiency was not to be had, a change could be made from parallel to tandem operation simply by connecting the discharge from one pump of each unit to the intake of the other, by which arrangement two units, each of a two-stage tandem pump, could be obtained. The pumps were built by the Morris Machine Works, of Baldwinsville, New York. Their total weight is 28,000 lbs. The motors to run the pumps were furnished by the Canadian Allis-Chalmers Company. They are 250 h.p. induction motors, 2,200 volts, 3-phase, 60 cycles, having a synchronous speed of 1,200 revolutions per minute.

The pumps were mounted on a scow built at the Crown Reserve shops on the shore of Kerr Lake, of western fir throughout. 6-in. x 6-in. frame timbers, and 3-in. plank for sides, deck, and bottom were used. After installing the pumps and motors the scow was housed with a weather-tight superstructure.

Power was obtained from the line of the Northern Ontario Light and Power Company, which passes through the property.

Flexibility of connection was obtained between the pumps and the shore end of the pipe by 20-in. flexible ball and expansion joints, joined by a connecting flanged length of 20-in. pipe. As the level of the lake lowered new lengths of pipe were inserted between the ball joints, and supported by trestle bents, having slings for lowering the pipe as the level changed. The ball joint on shore was firmly bolted to a cement pier, and when the scow's distance from shore became too great for practicable support of the connecting lengths of pipe, the ball joint was moved down to the new water line, and re-established on a new pier. The scow was moored with wire hawsers at each corner passing to shore. These hawsers were manipulated by small capstans set up on shore and on the deck of the scow. In addition, two 30-ft. 14-in. x 10-in. spuds were provided, running in wooden guides at the stern of the scow, which could be raised and lowered at will, but in practice it was found that the mooring lines were ample to hold the scow in position.

The 20-in. pipe line connecting the two lakes was of the spiral, riveted, bolted, joint type, supplied by the American Spiral Pipe Works. This pipe was laid on the ground where possible, but where inequalities of the country made it necessary, on simple bents, two to each length. When the pipe crossed the township highway it was laid in a culvert blasted from the rock, and where it crossed the track of T. and N.O. Railway it was carried over, at a distance of 23 ft. above the rail, by two four-post towers, built of 8-in. x 8-in. timbers, somewhat of the ordinary aerial tram type. The angle of crossing made a span of 90 ft., for which three flanged lengths were used, supported by strap hangers at 8-ft. intervals, hooking over four ⅞-in. cables, passing over the tops of the towers in pairs, and anchored by logs set 6 ft. under a stone fill. The pipe line was carried directly to the water level of Giroux Lake, and later was extended in a long curve by extra lengths of pipe, and by a flume, to a remote cove of the lake, in order to avoid muddying the main body of the water.

As the two operating companies, and the Cobalt Comet Mine, formerly obtained their water for mine and domestic purposes from Kerr Lake, a new supply was necessary to take its place. To this end a permanent pumping plant was installed on the shore of Giroux Lake. A well 10 ft. square and 12 ft. deep was sunk in solid rock at the water's edge, and a 5-ft. cut blasted through to the lake. Over this well a pump-house was erected, and two single-stage turbine pumps, each of a capacity of 500 imperial gallons per minute against a head of 175 ft., driven by direct-connected motors, were installed. The speed of operations of these pumps is 1,750 revolutions per minute. The motors are each 45 h.p., 2,200 volts, 3-phase, and 60 cycles. The water-carrying line for this supply is of 8-in. spiral, riveted, bolted, joint pipe, 1,300 ft. in length, connected with a 46-000-gallon receiving tank, erected on the highest point of land between the two properties. From this tank the supply for the different mines is piped.

By the arrangement of the pump intakes in the well above described, the difficulty of protecting the suction lines against freezing, and of building secure piers, which would have been met with had the lines been carried out into the lake, were obviated. The various distributing pipe lines were securely protected against freezing by water-tight wooden boxes filled with sawdust, and heated by a 1-in. line carrying steam from the boilers.

A signal system, in which a float in the receiving tank, by making various electrical contacts at different stages of water, lit warning lights and sounded an alarm bell at the pump-house, was put in, and was found to work successfully.

The draining pumps were started on August 28th, and operations proceeded steadily until the cold weather in the latter part of November caused suspension of work, until this spring. The clear water was taken out very rapidly, and during the last three weeks of last fall's operations the pumps were handling mud alone. In all, some 325,000,000 gal. of mud and water were removed at an average rate of 6,000 gal. per min. for 38 actual working days.

Although the lake was not totally de-watered last season, a sufficiently large area was cleared to make available for stoping and development the most important blocks of ground of the two companies, and it was demonstrated that the remaining fluid could be pumped without undue difficulty.

Several important veins were disclosed, some of which had not been known before. One of the encouraging features revealed by the exposure of the lake bed was the fact that the top parts of the veins had been little affected through oxidation of leaching by the lake waters.

Allowing for the usual delays in delivery of equipment, and for a few changes of minor importance in the working out of the scheme, the installation was expeditious, and the operation successful from the standpoint of the two companies concerned. The novelty of the undertaking consisted not so much in the mere project of pumping out the lake, as in the working out of the numerous details, to which careful attention was necessary owing to the wide difference in the nature of material to be handled by the pumps, acting from a moving base against an ever-increasing head, and in these respects the problems involved seem to have been satisfactorily solved.

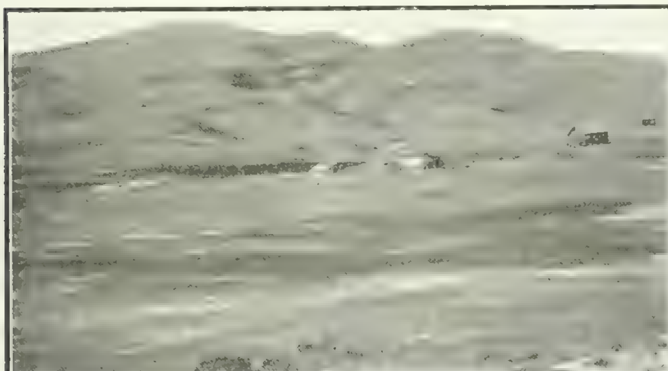
PROGRESS OF INVESTIGATION OF CLAY RESOURCES.*

By J. Keele,
Geological Survey of Canada.

During the season of 1913, the writer and two other members of the staff of the Geological Survey were engaged in examining clay deposits in various parts of the Dominion. The western provinces received the most attention, as they are dependent to a much larger extent on clay products for structural materials than the east.

The testing of clays and shales is one of the most important parts of this investigation, and occupies considerable time in the laboratory. An outline of the results of the field and laboratory work is as follows.—

Manitoba.—An examination was made of the shale deposits which are interbedded with the dolomitic limestones at the quarries in Stony Mountain and Stonewall.



White Fire Clay Beds in Dirt Hills, Saskatchewan.

Shale and Sand-stone Beds on Eastern Edge of Porcupine Hills, Southern Alberta.

White Clay in Edmonton Formation, Near Alix, Alberta.

Although these shales are hard and gritty, they become fairly plastic when finally ground and mixed with water, and capable of being moulded in clay-working machinery. Their lime content, however, is so high that they burn to a porous chalky body at all temperatures up to Cone 3 (1,190° C.). They could not compete with the surface clays of the district, which require no grinding and burn to a dense body at lower temperatures.

Samples of dark grey shales from Mafeking, sent to the laboratory for testing, were probably taken from the Benton division of the Cretaceous, which outcrops in this locality. These shales contained so much carbonaceous matter, as to be practically useless for the manufacture of clay wares. The carbon burns out of these shales with a bright flame, when they become heated to about 500° C., behaving in this respect like oil shales.

A plant for the manufacture of clay products is under construction at Carmen, this point being selected on account of the distributing facilities it offers for the manufactured wares. It is proposed to use the Niobrara shales from the Pembian Mountains near Leary, on the Carmen-Hartney branch of the Canadian Northern Railway. A carload of this shale was brought to Toronto during the winter and tested on a commercial scale in a sewer-pipe plant. The working and drying qualities of this shale were good, and a fairly satisfactory product with a bright salt glaze was turned out of the kiln.

Owing to the carbonaceous matter, and gypsum which this shale contains, the burning of wares made from it will be attended by some difficulty, until they are overcome by experience.

A mixture of the Niobrara and Pierre shales, both of which will occur abundantly in the Pembina mountains, will be found to give better results for sewer pipe.*

A consignment of clay samples from Sprague were tested in the laboratory. These, on testing, were found to be very similar to the surface clays at Winnipeg. They consist of an upper buff burning brick clay and a lower red burning clay. It is impossible to use the lower clay on account of its defective working qualities, but the upper clay makes an excellent common building brick.

Saskatchewan.—An examination was made of the clay deposits in the vicinity of the city of Saskatoon, and several samples were collected for testing. The results of the tests were not encouraging, as the materials present certain difficulties for successful working, and when these are overcome only the common grades of clay wares can be made from them.

Clay deposits at the town of Kamsack were investigated, the materials available at this point being buff burning surface clay overlying Niobrara shales of the Cretaceous formation.

The surface clays will make good building brick if burned sufficiently hard, but there is a tendency toward underburning and the consequent production of soft, porous wares.

The Niobrara shale in this vicinity is unworkable by wet moulded processes, owing to its excessive shrinkage and cracking in drying. This shale might be used for

*Published by permission of R. W. Brock, Deputy Minister, Department of Mines.

*Clay and Shale Deposits of the Western Provinces, Part II., page 93.

red dry-pressed bricks if the losses through fire checking did not run too high.

There is an extensive shale deposit almost precisely similar to this at Swift Current, an examination of which proved it to be subject to the same objections.

The Laramie formation in southern Saskatchewan contains clays which are the most valuable in the province.

The most important materials of this formation are the white or light grey, often sandy fire clays, and other deposits of a similar nature, but containing impurities which, for want of a better name, are called semi-refractory clays.

The fire clays of this region have fusing points between Cone 27 (1,670° C.) and Cone 32 (1,750° C.), while the latter fail in the fire test at Cone 15 (1,430° C.) to Cone 25 (1,630° C.).

Certain deposits of these types have already been described in published reports,* but their occurrence at a number of additional localities were recorded during the season of 1913, by Mr. B. Rose, of the Geological Survey and the writer, brief notes of which are as follows:

Fire clay occurs on sec. 14, tp. 11, Rg. 28, west of the 2nd meridian. This deposit is situated near the north end of Lake of the Rivers, not far from the Expanse branch of the Canadian Pacific Railway, and the Avonlea branch of the Canadian Northern Railway. Lignite also occurs in this vicinity.

Greyish white, soft clay, which is very gritty, was found in sec. 30, tp. 6, Rg. 18, west of the 2nd meridian. This clay has good plasticity and drying qualities. It burns white to grey, vitrified about Cone 10, and fuses at Cone 20. This deposit is situated near Brooking, on the Canadian Northern Railway lines.

A deposit of greyish white clay with rusty lumps, which farmers in the vicinity use as a plaster, occurs on sec. 31, tp. 3, Rg. 24, west of the 2nd meridian. This clay is very plastic, stiff and sticky. Its shrinkage is rather high, and its drying qualities are unknown. It burns to a buff color, vitrifies at Cone 10, with numerous dark fused spots on surface of test pieces. It fuses at Cone 20.

A bed of light grey, highly plastic clay was found about 7 miles south of Mortlach, on sec. 17, tp. 16, Rg. 1, west of 3rd meridian. This clay is said to be about 9 feet thick. It is overlain by a thin seam of lignite, and a bed of brown clay, containing gypsum particles. It burns to a cream color at lower temperatures, and becomes grey at high temperatures. It is vitrified at cone 9, and fuses at about cone 20. It resembles a stoneware clay, being very smooth and plastic, but the shrinkages in air-drying and burning are rather high.

Some samples of semi-refractory clay from southern Saskatchewan were sent to the clay-testing laboratory for examination. The amounts of clay sent were small, and no data was given regarding quantity or distribution of the deposits. One from the banks of the Frenchman River, near Eastend, resembles a stoneware clay, as it has good plasticity, rather smooth and burns to a grey vitrified body at cone 5. It fused at cone 15.

A small sample of clay was received from one of the smaller areas of the Laramie formation, north of the south branch of the Saskatchewan, sec. 17, tp. 21, Rg. 10, west of the 3rd meridian. This is the first specimen to be recorded from this area. It is a greyish white, rather sandy clay, with good plasticity and working qualities. It burned to a grey vitrified body at cone 9, and fused at cone 20. No information was received regarding the extent of the deposit or its distance from the nearest railroad.

Several samples of easily fusible, red burning clays were also collected at various localities from the Laramie formation in southern Saskatchewan. Most of these are open to objection on account of their poor drying qualities, and excessive shrinkages. It is possible that some of them can be used when mixed with the grey burning semi-refractory clays to produce bodies suitable for sewer pipe, face brick or fireproofing.

A sample of Pleistocene surface clay was received from Davidson, on the Regina branch of the Canadian Northern Railway. This clay cracked so badly in drying that it cannot be used for brick-making by any of the ordinary processes.

An effort will be made to use this clay by what is known as the ante-fired process, which consists in first calcining the clay in heaps as it comes from the bank. The calcined clay is ground in dry pans, mixed with a small percentage of lime, pressed into brick shapes, which are hardened in cylinders under a pressure of 120 pounds of steam. The method of procedure after the burned clay is ground is the same as in making sand lime brick. This process is in the experimental stage at present, but it may provide a way for using those clays which crack in drying.

Drying defects in clays are a serious difficulty in many of the Saskatchewan localities, and is one of the reasons that there are no brick plants along the main line of the Canadian Pacific Railway in this province. The probable cause of this defect, and a method of treatment to overcome it, was given in one of the reports of the Geological Survey.*

Alberta.—Our investigations up to the present time, have succeeded in recording the occurrence of fire clays only at one locality in this province. It is possible that fire clays, similar to those in Saskatchewan, will be found in the small area of the Laramie formation which extend into the southeastern portion of Alberta when the line of the Weyburn-Lethbridge branch of the Canadian Pacific Railway, now under construction, reaches that locality. Only a few places in Alberta were visited during the limited time at my disposal this season, which will be referred to briefly.

The occurrence of white clay near Nevis on the Lacombe branch of the Canadian Pacific Railway, was brought to my attention earlier in the season by Mr. J. O. Williams, of Camrose. This deposit was visited and samples collected for testing.

The material is a hard white or light grey shale about 4 feet in thickness. It is overlain by impure brown clay and underlain by grey shale impregnated with "bentonite."

The white shale is extremely plastic when ground and mixed with water, and cracks on drying.

It burns to a white to grey body, vitrifies at cone 9, and fuses at cone 16. It is not a fire clay.

The margin of the Porcupine hills nearest to the town of Macleod was also examined, and samples taken from 3 outcrops of shale at different levels. None of these proved to be refractory when tested.

A further examination was made of the shale deposits at Didsbury. The samples collected at this point were

*Preliminary Report of the Clay and Shale Deposits of the Western Provinces, Chapter III.; Part II. Clay and Shale Deposits of Western Provinces, Chapter III.

*Clay and Shale Deposits of the Western Provinces, Part II., Chapter VII.

satisfactory with regard to their working and burning properties, but a complete section of the beds could not be obtained.

It is impossible to state whether there is a workable body of shale or whether the sandstone beds were in excess.

These shales are in the Paskapoo formation, which yields the best material so far found in the province for the manufacture of wire cut brick, face brick or fireproofing.

Four samples from the clays and shales of the coal measures at Castor, sent to the laboratory for examination, were found to be defective in their drying qualities. These were from the Edmonton formation.

Drying defects in the clays of both the Edmonton and Belly River members of the Cretaceous are quite common. A drying test should always be made in the preliminary examination of these materials. A chemical analysis of a clay or shale is useless, the physical tests are the only guide to their value.

Athabasca River.—The following notes refer to some samples of clay collected by Mr. Sidney Ells, who examined the deposits of tar sands in Northern Alberta during last summer.

It may be noted that the clays secured were merely small samples from the surface of outcrops. During the warm weather bitumen and lighter oils seep out of the overlying tar sands, and run down more or less over the underlying strata. It is, therefore, possible that the body of these clays may be free of the contamination that exists on the outcrop from this cause.

An effort will be made during the coming field season to secure larger and more representative samples of these clays.

Lab. No. 187.—Dark grey, nearly black clay underlying bituminous sand on Moose River.

This clay is very plastic, fine grained, and smooth. It works up rather stiff and slightly sticky. Dries very slowly, with a drying shrinkage of 6.5%. This clay contains such a large percentage of asphaltic carbon that it is very hard to burn without swelling, unless burned very slowly during the oxidation stage. The density of body, due to the extreme fineness of grain, interferes with the expulsion of carbon, so that the oxidizing process of this clay is tedious.

The clay burns to a light red color at the lower temperatures, and to a buff or grey at higher. It vitrifies about cone 5, and is fused at cone 20.

This clay is of the stoneware type, but the carbon it contains is a detriment.

Lab. No. 188.—From east bank of Athabasca River, ⅓ mile above McMurray, Alta.

A dark grey clay, exceedingly plastic, and smooth, smelling strongly of asphalt when damp.

It burns to a light red color at a low temperature, becoming grey when heated up to cone 5 or thereabouts.

It fuses at cone 16.

Owing to its fineness of grain, and the fact that it contains a certain percentage of asphaltic carbon, this clay is very hard to burn. It could not be used unless a certain amount of it were calcined, ground, and added to the raw clay. This would improve its working, drying and burning qualities.

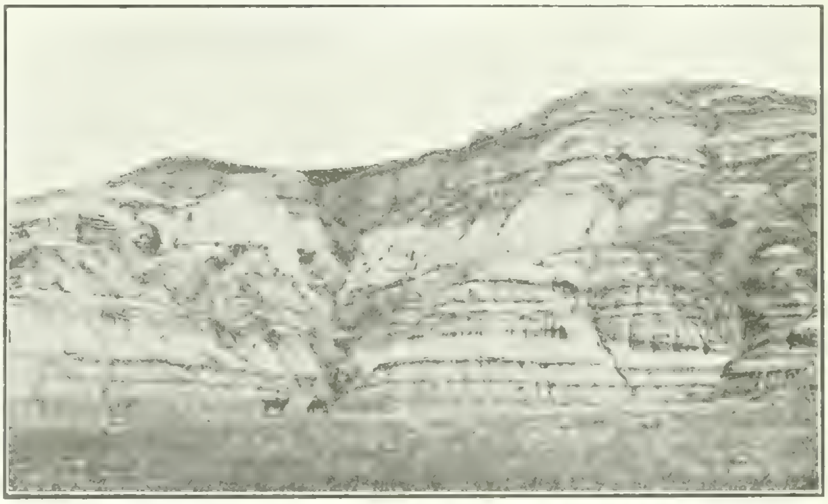
Lab. No. 190.—From point on N.W. shore of Muskeg River, between head of portage and mouth of river.

A light grey, very plastic clay, with good working and drying qualities. It burns to a cream colored, dense, steel-hard body at cone 3, with a total shrinkage of 9%, and softens when heated up to the temperature of cone 27. This is a good example of a stoneware clay, and is also a fire clay. It is the most refractory clay at present known to occur in the province of Alberta.

Lab. No. 191.—From Moose River, interbedded between bituminous sand and Devonian limestone.

Dark grey, very plastic, smooth, fine grained clay of the stoneware type. Burns to a salmon colored dense body at cone 3, with rather high shrinkage, and fuses at cone 18.

Summary.—These four examples of clay are alike in many of their physical characteristics, and appear to occur in the same geological horizon, viz., underlying the tar sands, on the Athabasca River, and its tributaries.



Typical example of clay and lignite beds in valley of Big Muddy River, South Saskatchewan.

They are very fine-grained sediments, and low in fluxing impurities, No. 190 being exceptionally so, hence they are more refractory than any of the Cretaceous clays from the southern part of the province.

The samples were too small in size to allow of complete determinations concerning their working and drying qualities, but they appear to be free from the drying defects so common to the western Cretaceous clays.

These clays are of the stoneware type, being exceedingly plastic, and burning to a light colored dense body at cone 5, while they retain their shape without softening when fired to much higher temperatures. Their most serious defect is due to the presence of asphaltic carbon, which renders the safe burning of wares made from them a difficult process. Nos. 190 and 191 appear to be free from this impurity, as far as could be told from the small samples, and these clays would be valuable for many purposes.

Owing to their position under heavy overburdens, and the remoteness from transportation at which these deposits occur, it is doubtful if they can be included in the economic resources of the region, at least for some time to come.

CRITICAL LOADS FOR IDEAL LONG COLUMNS.*

By Arthur Morley.

THE usual process of obtaining Euler's value of the critical load for the ideal case of a long, straight, axially loaded column of uniform cross-section is well known. It consists: (1) In writing from the simple theory of flexure the differential equation to the curve of bending in terms of the load, dimensions, modulus of elasticity of the material, and an arbitrary deflection at some selected cross-section of the column. (2) In solving the equation in conformity with the assigned end conditions of the column, thus deriving a general expression for the deflection. (3) In equating the appropriate value of this general expression to the arbitrary value previously assumed at the selected cross-section and solving for the value of the load.

For the third step we may, of course, substitute the method of equating the elastic strain energy of the column to the work done by the load in producing the deflection. If we use the correct form of curve, the result will be identical with that obtained from an equation of lateral displacements, but the work involved would be greater, and this latter alternative therefore offers no advantages to the designer.

Now, if we assume a general form of deflection and represent it by an algebraic expression, and use this in an equation of displacements or in the equation of work, we shall obtain a value of the critical load. Whether the value so obtained is, or is not, a good approximation to the true critical load depends mainly on whether the assumed form of deflection is, or is not, a good approximation to the true curve. For example, taking the fundamental case of a column of length l, fixed in direction at one end and quite free at the other, the deflection at a distance x from the free end bears to that at the free end a ratio of $1 - \sin \frac{x}{l} \frac{\pi}{2}$; this curve lies fairly close to that taken up by a corresponding cantilever transversely loaded at its free end, which gives a deflection $\frac{(l - x)^2 \, (2l + x)}{2l^3}$ of that at its free end, and if this latter form be assumed for the column deflection, a good approximation to the critical load will result. But in the case of a column which tapers from the fixed end to a very much smaller section at the free end, the corresponding assumption is not a safe one, and will lead in some cases to an enormous over-estimate of the critical load. The assumption of a curve flatter than the true form leads to over-estimates of the load, and that of a form of exaggerated general curvature leads to under-estimates.

Method of Successive Approximation.—The following method may be applied to struts of any kind, whether uniform, in cross-section, or otherwise; for the purpose of explanation, the case of a column fixed at one end and free at the other will suffice, but there is no limitation to the type of end condition in the application of the method.

As a first approximation, assume any deflection of the free end, and any simple form of flexural curve connecting the free and the fixed ends—even a straight line, however impossible as a final result—will serve in the first instance as a good starting-point.

*Reproduced from April 24th issue of Engineering (London).

Secondly, use the assumed form of deflection in place of the unknown form in the differential equation to the curve of bending. Thirdly, by two integrations, with due regard to the end conditions for the determination of the constants of integration, obtain a general expression for the deflection at any cross-section of the column. Fourthly, equate the resulting deflection at the free end to that previously assumed, and solve for the load. This is the approximate solution previously described, and may be called a first approximation. Next write the general expression for deflection in terms of the derived value at the free end; this is a second approximation to the true form, and if treated in the same way as the first approximation will yield a third approximation, and so on indefinitely, each step yielding in general a new flexural form and a new value of the critical load. Successive values, after a few repetitions, tend noticeably towards a fixed limit, and this is the true critical value. It is quite easy to obtain a good approximation from a straight line as a first approximation; this gives a linear distribution of bending moment corresponding to a cantilever with a transverse end load, so that the second approximation starts with a curve corresponding to the cantilever curve. Particularly with such a simple initial assumption, it will generally be noticed that the successive coefficients in the critical loads are falling into an ordered sequence, and that after a few integrations the coefficients for further approximations may be picked out by inspection from the sum of a series. By proceeding to the limiting value for an indefinitely great number of repetitions, which may be

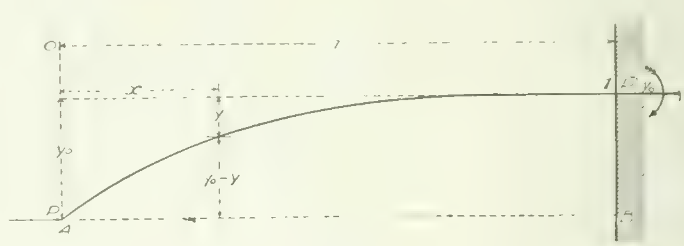


Fig. 1.

quite easy to determine, we may be able to write down an exact, instead of an approximate, value for the critical load.

For a strut, the cross-section of which changes from point to point along its axis by any but a simple continuous law, the determination may conveniently be carried out graphically. Any deflection curve initially assumed constitutes on a base-line through the free end parallel to the original direction a curve of bending moments ($M = P\,(y_0 - y)$, Fig. 1) for the strut under the action of the thrust, and well-known graphical processes give the resulting deflections. An equation of displacements then gives the first approximation to the critical load. The resulting curve of deflections may in turn be similarly treated to give a second curve, and so on until reasonable constancy is attained. Whether the treatment be graphical or algebraic, if the arbitrary choice of a first deflection curve should happen to correspond to the true form, the second form will exactly correspond to the first, and exact repetition will follow as often as the process is carried out.

The following examples illustrating this method are worked out for the case of a column fixed at one end and quite free at the other; from this case other important ones can be simply deduced by well-known relations. The first example is worked in some detail.

Notation.—Let o, Fig. 1, be the origin at the undisturbed position of the free end of the strut, x be the distance along the strut, and y the deflection. Let the suffix 1 refer to the fixed end, and the suffix o to the free end. Let l be the length of the column, I the moment of inertia of its cross-section about a central axis in its plane, and E be Young's modulus of elasticity for the material, and P be the axial thrust at the free end.

Then, in all cases the equation of simple bending is:

$$E\,.\,I\,.\frac{d^2y}{dx^2} = P\,(y_0 - y). \qquad (1)$$

Example I.:—

Let the column be of uniform section—i.e., I = constant.

First Approximation.—Assume the deflection to be along a straight line 1 A (Fig. 1)—i.e.:—

$$y = \frac{l-x}{l}\,y_0, \text{ or } y_0 - y = \frac{x}{l}\,.\,y_0. \qquad (2)$$

Then equation (1) becomes:—

$$E\,I\frac{d^2y}{dx^2} = P\,y_0\frac{x}{l} \qquad (3)$$

Integrating twice under the condition $\frac{dy}{dx} = 0$, and $y = 0$ at the fixed end—i.e., when $x = l$.

$$E\,I\,y = \frac{P\,y_0}{2\,l}\left(\frac{1}{3}x^3 - l^2x + \frac{2}{3}l^3\right) \qquad (4)$$

and at $x = 0$,

$$E\,I\,y_0 = \frac{P\,.\,y_0\,.\,l^3}{3} \qquad (5)$$

from which the first approximation is:—

$$P = \frac{3\,E\,I}{l^2} \qquad (6)$$

Second Approximation.—Dividing (4) by (5),

$$y = y_0\left(\frac{1}{2}\frac{x^3}{l^3} - \frac{3}{2}\frac{x}{l} + 1\right) \qquad (7)$$

which is the form for a cantilever with a transverse end load, as might be foreseen from (3), in which the bending moment is proportional to x; when known it might be chosen as a starting point instead of the simpler form (3), which does not comply with the condition $\frac{dy}{dx} = 0$ for $x = l$. Using the form (7) in (1),

$$E\,I\frac{d^2y}{dx^2} = P\,y_0\left(\frac{3}{2}\frac{x}{l} - \frac{1}{2}\frac{x^3}{l^3}\right) \qquad (8)$$

whence, proceeding as before,

$$E\,I\,y = \frac{P\,y_0}{40\,l}\left(10\,x^3 - \frac{x^5}{l^2} - 25\,l^2x + 16\,l^3\right) \qquad (9)$$

and

$$E\,I\,y_0 = \frac{16}{40}\,P\,l^2 \qquad (10)$$

$$P = 2.5\,\frac{E\,I}{l^2} \qquad (11)$$

Third Approximation.—Dividing (9) by (10),

$$y = y_0\left(\frac{5}{8}\frac{x^3}{l^3} - \frac{1}{16}\frac{x^5}{l^5} - \frac{25}{16}\frac{x}{l} + 1\right) \qquad (12)$$

And again substituting in (1),

$$E\,I\frac{d^2y}{dx^2} = \frac{1}{8}P\,y_0\left(\frac{1}{2}\frac{x^5}{l^5} - 5\frac{x^3}{l^3} + \frac{25}{2}\frac{x}{l}\right) \qquad (13)$$

from which,

$$E\,I\,y = \frac{1}{32}P\,y_0\left(\frac{1}{21}\frac{x^7}{l^5} - \frac{x^5}{l^3} + \frac{25}{3}\frac{x^3}{l} - \frac{61}{3}\,l\,x + \frac{272}{21}\,l^3\right) \qquad (14)$$

$$E\,I\,y_0 = \frac{1}{32}P\,y_0 \times \frac{272}{21}\,l^2 \qquad (15)$$

$$P = \frac{42}{17}\frac{E\,I}{l^2} = 2.4706\,\frac{E\,I}{l^2} \qquad (16)$$

The successive approximations are $E\,I \div l^2$ multiplied by 3, 2.5, 2.4706, 2.4677 . . . etc., where the true coefficient is well known to be $\frac{1}{4}\pi^2 = 2.4674$ . . .

Each successive approximation for y approaches more nearly the true value—viz., $y_0\left(1 - \sin\frac{x}{l}\,.\,\frac{\pi}{2}\right)$.

Thus the true value at $x = \frac{1}{2}\,l$ is $y\left(1 - \frac{1}{\sqrt{2}}\right) = 0.293\,y_0$, whereas (2), (7), (12) give respectively $0.5\,y_0$, $0.3125\,y_0$, $0.295\,y_0$. The successive curves are each flatter than the true curve, and give a value of P in excess of the true value.

An alternative to the form (2) would have been to assume a parabolic curve:—

$$y = \frac{(l-x)^2}{l^2}\,.\,y_0 \qquad (17)$$

which satisfies both $y = 0$ and $\frac{dy}{dx} = 0$ for $x = l$. In this case the successive approximations are $\frac{E\,I}{l^2}$ multiplied by the factors 2.4, 2.4590. These are below the true value $\frac{1}{4}\pi^2$; correspondingly the values of y indicate more curvature than in the true sine form. For $x = \frac{1}{2}l$, (17) gives $y = 0.25\,y_0$, and the second approximation gives $y = 0.2875\,y_0$, as against the above true value $0.293\,y_0$.

The form (17) is the curve taken by the column under the action of a couple at its free end. This will, with any type of column, give a curve of exaggerated curvature and an approximation on the safe side, to the critical load. It will also provide a starting-point for approaching the true limit from the safe side. By starting from both sides it is more easy to judge the value of the limit from a very few trials when the limit is approached slowly.

Example II.:—

Let I vary as the distance x from the free end—i.e.:

$$I = \frac{x}{l}\,I_1 \qquad (18)$$

First Approximation.—Assuming the form (2) equation (1) becomes:—

$$E\,I_1\frac{d^2y}{dx^2} = P\,y_0 \qquad (19)$$

which gives:—

$$y = \frac{P\,y_0}{2\,E\,I_1}(x-l)^2, \text{ and } y_0 = \frac{P\,y_0\,l^2}{2\,E\,I_1} \qquad (20)$$

Hence

$$P = \frac{2\,E\,I_1}{l^2} \quad . \quad . \quad (21)$$

Second Approximation.—

$$y = y_0 \frac{(x-l)^2}{l^2} \quad . \quad . \quad . \quad (22)$$

when substituted with (18) in equation (1) gives:—

$$E\,I_1 \frac{d^2 y}{d\,x^2} = P\,y_0 \frac{2\,l - x}{l}. \quad . \quad . \quad (23)$$

Two integrations then give:—

$$y = \frac{P\,y_0}{E\,I_1\,l}\left\{-\tfrac{1}{6}x^3 + l\,x^2 - \tfrac{3}{2}\,l^2\,x + \tfrac{2}{3}\,l^3\right\} \quad (24)$$

$$y_0 = \frac{P\,y_0\,l^2}{E\,I_1} \times \tfrac{2}{3} \quad . \quad . \quad . \quad . \quad . \quad (25)$$

$$P = \tfrac{3}{2}\frac{E\,I_1}{l^2} \quad . \quad . \quad . \quad . \quad . \quad (26)$$

The successive factors of $\frac{E\,I_1}{l^2}$ in the values of P are 2, 3/2, or 1.5, 16/11 or 1,45, 495/341 or 1.4516. ∴ . The assumption (17) is identical with (22), and leads to the same series of approximations.

The limit is in this case approached so rapidly that $P = 1.45 \frac{E\,I_1}{l^2}$ may be taken as a good approximation.

Example III.:—

Let I vary as the square of the distance from the free end—i.e.:—

$$I = I_1 \frac{x^2}{l^2} \quad . \quad . \quad . \quad (27)$$

Following the method of the previous examples, the successive coefficients of $\frac{E\,I_1}{l^2}$ in the values of P are 1, ½, 2/5, 5/14, 1/3, 7/22, . . . etc.

Here the limit is approached much more slowly, and evidently the first two approximations are very bad and yield very incorrect value of P on the unsafe side. From the way in which the coefficients develop in the integrations (which would take too much space to reproduce in full) it becomes evident that successive values may be written from the numbers in Table I., overleaf. These numbers are interesting and very simply related; the constitution of the first two lines is obvious, and the lowest number in each column is a repetition of the one above it. All rows after the first may be written by making each number the sum of that above and that to the left of it.

Successive approximations to the coefficient of $\frac{E\,I_1}{l^2}$ are obtained by dividing the sum of any column by the sum of the succeeding column; for the word "sum" "last number" may be submitted, since the last term in any column is equal to the sum of the previous column. To reach any degree of approximation is now only a question of simple arithmetic, but we may algebraically proceed to the limiting value of the coefficient. The successive numbers in the $(n+1)$th column are:—

$$1,\ n,\ \frac{n(n+1)}{1.2} - 1,\ \frac{n(n+1)(n+2)}{1.2.3} - 2,$$

$$\frac{n(n+1)(n+2)(n+3)}{1.2.3.4} - \frac{n(n+1)}{2} - 2n - 3, \text{ etc.}$$

The nth number is

$$\frac{n(n+1)(n+2)\ .\ .\ .\ .\ (2n-3)(2n-2)}{n-1} -$$

$$\frac{n(n+1)(n+2)\ .\ .\ .\ .\ (2n-4)}{n-3} - 2\,\frac{n(n+1)(n+2)\ .\ .\ .\ .\ (2n-5)}{n-4}$$

$$-\,3\,\frac{n(n+1)(n+2)\ .\ .\ .\ .\ (2n-6)}{n-5}, \text{ etc.,}$$

$$-\,\frac{(n-5)(n+2)(n+1)n}{1.2.3} - \frac{n(n-4)(n+1)n}{1.2}$$

$$-\,(n-3)\,n - (n-2).$$

Taking the ratio of the nth number of the $(n+1)$th column to the $(n+1)$th number of the $(n+2)$th column, and proceeding to the limit in which n is indefinitely great, we find the limiting value of the coefficient to be ¼.

If we assume the form (17) as a starting point, the successive approximations to the coefficient of $\frac{E\,I_1}{l^2}$ are ⅔, 6/13, 26/67, 134/381, etc., for which a table may be constructed to give further approximations by arithmetic; the table is not quite so simple as Table I., but gives, of course, the same limiting value, and the alternative offers

Table I.

	1	1	1	1	1	1	1	1	1	1
		1	2	3	4	5	6	7	8	9
			2	5	9	14	20	27	35	44
				5	14	28	48	75	110	154
					14	42	90	165	275	429
						42	132	297	572	1,001
							132	429	1,001	2,002
								429	1,430	3,432
									1,430	4,862
										4,862
Totals	1	2	5	14	42	132	429	1,430	4,862	16,796
Coefficients of $\frac{E\,I_1}{l^2}$	1	$\frac{1}{2}$	$\frac{2}{5}$	$\frac{5}{14}$	$\frac{14}{42}$	$\frac{42}{132}$	$\frac{132}{429}$	$\frac{429}{1,430}$	$\frac{1,430}{4,862}$	$\frac{4,862}{16,796}$
Coefficients as decimals	1	0.5	0.4	0.3571	0.3333	0.3182	0.308	0.300	0.2941	0.2894

no advantages. By modifying a numerical coefficient in, say, the second approximation for y, we may bring the resulting value of the coefficient of $\frac{EI_1}{l^2}$ near or exactly to $\frac{1}{4}$, but the succeeding values will go away from the true coefficient, and then gradually approach it again, so that the simplest assumption (2) appears to be as good as any other. This example scarcely represents a type of practical column, but it illustrates well the method of successive approximation and the entire unreliability of the early approximations in certain cases of columns of variable section. Its exact solution may be obtained from the differential equation (1), which, with (27), becomes—

$$x^2 \frac{d^2 y}{d x^2} + \frac{P l^2}{E I_1} \cdot y = \frac{P l^2}{E I_1} y_0 \quad . \quad (28)$$

The solution under the assigned conditions is—

$$P = \frac{1}{4} \frac{E I_1}{l^2} \text{ and}$$

$$y = y_0 \left(1 - \sqrt{\frac{x}{l}} - \frac{1}{2} \sqrt{\frac{x}{l}} \log \frac{x}{l} \right) \quad . \quad . \quad (29)$$

a value which will, of course, repeat itself after a succession of integrations of equation (1). How greatly the second value of y, which is—

$$y_0 \left(\frac{x}{l} \log \frac{x}{l} - \frac{x}{l} + 1 \right) \quad . \quad . \quad (30)$$

corresponding to the end loaded cantilever curve, differs from (29) is evident by comparing the values of y for, say, $x = \frac{1}{3} l$; the form (29) gives $y = 0.105 y_0$, while (30) gives $y = 0.301 y_0$.

The weakness of this column lies in the flexibility of its free end, which would also reach the elastic limit before the critical load, unless modified in shape.

(To be continued.)

A NEW ELECTRICAL DIRECTORY.

The McGraw Electrical Directory.—The last semi-annual issue of the McGraw Electrical Directory has been received. This very useful book contains a list of central stations in the United States, Canada and Mexico, giving for each station full particulars of equipment, personnel of operating force, ownership, etc. This issue gives the details of 434 Canadian companies, including municipal systems. This list includes nine companies that have been organized since the publication of the last half-yearly list. The total number of generating stations in Canada is 402, not including substations. The number of companies purchasing energy is 28, while there is an equal number of municipal systems purchasing energy. There are 175 municipal lighting systems. In Canada, electrical supplies are carried by 244 of the firms or municipalities. Much other useful information is also contained in the volume, which is 726 pages, size 4¼" x 8½". The price of the Directory is $5.00, and it can be ordered through the Canadian Engineer Book Department.

A Chicago report of June 6 states that the plans for that city's new west side terminal railway station have been approved by the Illinois public utilities commission.

A recent report from New York states that the New York Central lines have contracted for 7,300 freight cars. This order is the largest since the purchase of 12,000 cars last year by the Pennsylvania lines. The New York Central has divided its order between the American Car and Foundry Company and the Standard Steel Car Company, the former to supply 4,300 cars, and the latter 3,000 cars.

UNIT PRICE vs. LUMP SUM CONTRACTS.

MANY arguments have been advanced to uphold the advantages and disadvantages of the various methods in vogue by which the contractor receives his remuneration for work which he has undertaken to do. It is generally understood that there are imperfections connected with each, but that under certain conditions one may be considerably better than another. In a paper which he read last fall at the 10th annual convention of the American Road Builders' Association in Philadelphia Mr. H. C. Hill brings forth a number of arguments in favor of the unit price method, and attempts to prove that in the majority of cases contract work on this basis is the correct method. He argues that percentage work is nothing more than day labor, so far as the cost of manual work is concerned. It differs in total cost only in that there is at the start an organization with a certain knowledge of how the work should be laid out and executed, directed by a man or firm whose reputation for doing work at a reasonable cost is at stake.

The following is a portion of Mr. Hill's paper:—

Contract work has every advantage that percentage work has, and something in addition, namely, an incentive, which constantly spurs every man, to a more or less degree, depending upon his nature, to do the work set before him in the most economcial manner and with the least expenditure of energy. Some will say that this is too true and leads in a few cases to poor work. If this is so, it is not the fault of the method, but the fault of those doing the work, more particularly those having supervision; for it is possible to eliminate entirely those contractors who desire only to make as large a profit as possible, irrespective of the class of work done—and it has been done.

An attempt has been made to instill "incentive" into percentage work by establishing a price on each unit of work and paying a bonus on a sliding scale if the work is done at a cost less than that first agreed upon. This is a very delusive point, and those familiar with the variable factors in cost data will readily see the futility of it. Furthermore, it will not take much of a mathematician to figure that it is the percentage and not the bonus that gives the contractor his profit, unless the agreed price is considerably higher than the actual cost should be. It being true, then, that percentage work tends to increase the cost of the work, there remains the question of under what method of payment contract work shall be done.

In comparing the advantages and disadvantages of lump sum and unit price contracts, it is possible to consider them under two heads, namely, the engineering feature and the moral aspect.

The point upon which the advocates of the lump sum method lay the greatest stress is that the cost of work is reduced by having the engineering charges a minimum. Those of this opinion are wont to tell how much cheaper work is done, basing their comparison on an average cost—as in highway construction the average cost per mile—instead of basing the comparison upon the actual amount of material moved or used. The truth or falsity of this statement is not subject to any specific proof, for it is impossible to have the same piece of work done by both methods, but it is subject to proof in a general way. A very close approximate might be obtained, if desired, by procuring bids for the same piece of work on each method, then after the completion of the work comparing the average of all the lump sum proposals with the average total of the unit price proposals,

using, however, as a basis for the latter, not the actual unit quantities as shown by a final estimate, but the bidding schedule quantities. This is, perhaps, more theoretical than practical, but satisfactory proof that under lump sum contracts the work costs more is furnished by the fact that no reliable, experienced contractor will bid as low on a lump sum proposal as he will if the work is to be let on a unit price proposal. This is a definite statement, but one which a majority of contractors will agree to, and for this reason: Contract work in any form contains certain factors the exact nature of which it is impossible definitely to determine until after they are encountered, and every contract, except it be a percentage contract, must necessarily be more or less of a gamble. Therefore, no contractor overlooks this factor —and you can rest assured that the larger the risk the higher the bid. This element of risk is less on a unit price contract than on a lump sum; for under the former, should a certain class of work increase over the estimate, the contractor gets a corresponding increase in pay, and should less work be done he gets a corresponding decrease in pay. Under the lump sum method such changes have no effect upon the amount of money received by the contractor for doing the work.

In some cases under lump sum bids, estimates for the various quantities are prepared, but the general practice is for the bidder to ascertain these for himself, either by his own engineer or by guess based upon general knowledge. Even in cases where careful estimates are prepared, the final quantities are not the same as those upon which the bid was made out; therefore, as far as payment is concerned under this method, estimates are of no positive value. The fact, however, that there is a variance between the preliminary and final estimates is not the fault of an engineer, for it is impossible to determine accurately the exact quantities until the work is completed.

The theory of the unit price method is a very simple and just one. Expressed in a few words it conveys this idea: The contractor is to be paid for just what he does and to do just what he gets paid for. Nothing could be more equitable than this. However, like everything else, it has its imperfections, but not of a very serious nature. Its weakness lies not in itself, but in the hands of inexperienced men, incapable through ignorance of properly preparing unit quantities. This weakness causes what is known as unbalanced bidding, and consists of bidding high on items the estimate of quantities of which in a contractor's judgment is lower than will be used, or vice versa, and so regulating his bid on these items that he will lower his total bid and at the same time increase the aggregate amount he will receive for doing the work. This results sometimes in putting an engineer in an embarrassing position. Those who condemn this method should ask themselves if an unbalanced bid is any worse than an unbalanced bidding schedule prepared by engineers, and if criticism of unit price contract methods is not primarily due to those who make the estimates and not to the contractors. If engineers were as careful not to leave any loopholes in preparing estimates for contractors to bid on as they are making out specifications for doing the work, unbalanced bidding would become almost an unknown quantity.

Another advantage of having work done by unit prices is that it enables changes to be made while the work is in progress with the least possible chance of any dispute, and as a rule at a less cost than by the lump sum method. Oftentimes such changes are to the disadvantage of the contractor, but the majority of them realize that the changes are necessary for the proper [illegible] of the work; and so much more satisfactory to them are unit prices that they prefer to do work by this method, submitting willingly to such additions or deductions as may be found necessary while the work is in progress. While changes are, of course, possible under the lump sum method, so much is involved that only as the last resort is any change made. This is unfortunate, for often during construction it is possible to make some alteration that will improve the work and perhaps save more than the total engineering expense of having the work done on a unit price basis.

Great as are the advantages of the unit price contracts, viewed from the engineering standpoint, they are even greater from the moral standpoint. To make money is obviously the principal object of every contractor who earns a living by his work. The word "principal" is used instead of "first" to differentiate. His first object should be to do as good work as is intended by the specifications. It is, however, the nature of many people not to do the task set before them in as careful, thorough and complete a manner as desirable. In this respect contractors, and more particularly their employees, are not unlike others; hence the importance of any method of payment that will remove the temptation to do poor work. It needs only a superficial examination of a lump sum contract to see that not only is the incentive to do faithful work absent, but there is also a premium for not doing it.

STEEL DIRECT FROM ORE.

Now that modern conditions demand such severe specifications for steel, it is an undoubted fact that the steelmaker is experiencing greater and greater difficulty in meeting these demands. The difficulties experienced in eliminating such impurities as oxygen, phosphorus, sulphur and silicon, and the practical failure to eliminate nitrogen and hydrogen, have naturally led to a search for a method of manufacture with which a purer steel could be more readily obtained. An account of some experiments to this end were given at a meeting of the Iron and Steel Institute of Great Britain recently. An electric furnace was selected, the ease with which it can be controlled, and oxidizing and reducing conditions obtained at will, being the chief factors influencing this decision. Three series of tests were made—viz. (a), direct reduction of silicious Swedish iron ore; (b) direct reduction of Swedish and a silicious Swedish iron ore, with 30 per cent. of scrap mixed in the charge; (c) direct reduction of Brazilian iron ore. The result was the production of a steel of great toughness, and having regard to the fact that so much is heard of the baneful effect of nitrogen and hydrogen in steel, it is claimed as a distinct advantage of the process that these gases are never introduced into the charge. The result is that the conclusion has been arrived at, by those who carried out the experiments, that with the aid of the modern electric furnace, and given satisfactory conditions, the economic manufacture of steel direct from ore is a practical possibility. It is suggested that a special type of Héroult furnace will be developed for the purpose, and probably the best use for the process will be found in countries which possess readily available sources of water power, together with deposits of pure rich ores. There is considerable scepticism, however, on the part of many as to the possibility of making any such process a commercial success. That steel can be manufactured in this way is not denied, but its manufacture on a competitive commercial scale, except for very special purposes, is seriously doubted. The fact that it has been tried before and failed, however, does not necessarily prove conclusively this argument.

The annual report of the Department of Mines of the Dominion Government declares that "the district between Regina and Moose Jaw, and the district along the Alberta boundary in Saskatchewan is reported to offer a chance for oil operations." It is rumored in Regina that an oil expert will investigate the matter in the near future

Editorial

MECHANICAL TREND OF ROAD CONSTRUCTION.

The problems which the development of mechanical traction upon our highways has occasioned are manifestly well distributed. The financing, engineering and construction phases of road building are each effected in relatively proportionate ways. Greater expenditure upon construction and maintenance for the first, changes in design and materials attended by new forces, and to be solved under more stringent conditions than formerly, for the second; and changes in the method of carrying out these plans and designs, in the case of the third, have produced three-cornered problems coincident and interdependent upon each other.

The greatest changes, however, have transpired in the methods of construction. The production of labor-saving machinery and equipment, in evidence wherever there is a road development or organization, has created a necessity for expert attention and care, in order that this machinery may be efficient of operation and long of life. The situation has been well explained by Mr. H. T. Routly, well-known for his road building in Northern Ontario and in Quebec, in a paper recently presented to the University of Toronto Engineering Society. He states: "Once a system of roads has been located, designed and laid out by the civil engineer his work is practically over—except for passing the estimates of work done. The business of actual road *construction* is a question of machinery in three phases: (1) selection and purchase, (2) operation and care, (3) maintenance and repair. And here is an ever-widening and remunerative field for students and graduates in mechanical engineering, with suitable positions as stepping stones all along the line and at its best during the students' vacation season. Few of them are taking advantage of the opportunity. The positions are filled mostly by men who have graduated from a threshing engine in one season. Many have to be trained on the work without previous experience. As a matter of fact, these latter men are usually the more satisfactory, for they come admitting their inexperience and readiness to learn. They are usually very careful, and while ambitious for advancement, are more willing to earn it by strict attention to duty. But their lack of technical education is so serious a handicap that they can rarely reach the higher ground and are unable to render themselves as useful to their employers as they otherwise might.

"It is seldom that a road outfit is found under the charge of a first-class practical mechanic or engineer, and yet nowhere are his services more urgently needed. The man in charge of all such outfits, whether owned by municipalities or by contractors, should be first of all a manager of men, after that a first-class machinist, and lastly, a practical road builder. Others may arrange these essential requirements differently; all will agree about the first requirement, being the ability to handle his men; I maintain that it is easier for the machinist to acquire a thorough knowledge of practical road building than for the road builder to acquire a thorough knowledge of the machinery he is required to use. Without that knowledge he is only half efficient and is always at the mercy of and dependent upon his various machine men, his lack of such knowledge detracting from his prestige not only with the machine men themselves but with the other men as well.

Ordinarily a road outfit will be working at some distance from any machine shop where repairs can be readily obtained. The building season is short at the best, and delays for machinery repairs very expensive. The superintendent who can detect and remedy faults before they become dangerous and who can repair on the ground the ordinary breaks, is able to keep his plants working a much greater percentage of the possible working time and to save a larger proportion of maintenance and depreciation charges than the superintendent who lacks the thorough knowledge of his machinery.

"PRACTICAL" AND "THEORETICAL" DESIGNING.

In *The Canadian Engineer* for June 4th, 1914, appeared an article entitled "Practical Design of Steel Structures." The writer, as the title suggests, is emphatic in his estimation of the value of "practical" compared with "theoretical" design. Some interesting comments upon the paper have appeared in a recent issue of "Engineering and Contracting," which will be found interesting, no doubt, by many who had read the article referred to. Our contemporary emphasizes the absurdity of any division of the subject into two classes: "practical designing" and "theoretical designing," as follows:

One is just as "practical" as the other, and neither is "theoretical" (which means not practical or depending on theory). The making of preliminary plans most certainly should be in charge of a man who is essentially practical. . . . We believe that it is a mistake to attempt to set apart, arbitrarily, one branch of engineering design as "theoretical," and assign to it men who have received training in our engineering schools, and another branch as "practical," and to place in charge of it men who have gained their entire knowledge of engineering from the school of experience. Either type of man may become eminently successful in any branch of engineering, provided he has the proper desire and ability to learn and the necessary application. To be successful in any branch of engineering one must be essentially practical, and this quality cannot be measured by the fact that a man has or has not received training in an engineering school. Such a training, however, we believe is advisable.

The field of engineering has broadened so much in the last twenty years, that it is no longer possible to say just what it includes or excludes. It has no hard and fast line of limitation, nor yet are the lines of division between its various branches quite distinct. This is a condition which has had to be met, in the education of the young engineer, by drafting into the university, as teachers, men of high professional standing from the world without. Such men are best capable of giving useful instruction in theory, and demonstrating, by live examples from the field, how and where theories apply in practice. They have come to possess, moreover, through the ups and downs of their experience, a keener and warmer sympathy for the student in the profession.

ROAD PRACTICE IN BIRMINGHAM, ENG.

SOME interesting references to methods of road construction and maintenance in Birmingham, Eng., were brought out by Mr. H. M. Lawson, Deputy Road Surveyor for that city, in a paper read on March 5th, 1914, at a meeting of the Institution of Municipal and County Engineers. Mr. Lawson's paper dealt with water-bound macadam, tar-spraying, asphalt macadam, sett-paving, sheet asphalt, and street-cleaning. The following notes, dealing with several of these, are abstracted from his address:—

In many instances water-bound macadam roads are condemned as useless under average traffic conditions; the chief reason for this is that in many cases these roads have no foundations or proper drainage. Therefore it is of great importance to get a solid and well-drained foundation, and adequate surface drainage; also to ascertain that every care has been taken to decide the wearing qualities of the stone employed, and to ensure that it is of one uniform quality. It is obvious to any road enginer that, wherever one has stones of different qualities (and this applies also to stone-sett and wood paving), the softer stone soon begins to show itself by wearing down below the harder, resulting in a series of up and downs.

The city engineer of Birmingham, in dealing with the construction of new water-bound macadam roads carried out by contractors, has a specification which is strictly adhered to, inspectors being appointed for the special purpose of looking after this class of work.

The form of construction is as follows: A layer of clean clinker ashes or broken stone, 6 in. in depth when rolled solid, is followed by a second layer, consisting of hand-pitched slag, 6 in. to 8 in. in depth (according to the nature of the traffic), set on edge, in the manner of a rough pavement. Over this layer a coating of broken slag or other approved material is laid, so as to fill up the interstices to form a smooth surface; each layer is thoroughly consolidated. A row of 4-in. by 6-in. granite setts on concrete is laid outside the channel stone as a margin course. The metalling for finishing the carriageway is then spread with forks in two coats. The first coat having been uniformly spread over, the whole carriageway is then rolled until consolidated. The second coat is then uniformly applied and consolidated, making a thickness of 6 in., the surface then receiving a coating of fine clippings of the same description of material as the metalling used; the chippings are screened through a ¾-in. mesh, and include the finer material, down to dust. The carriageway is then lightly watered and rolled until thoroughly consolidated, two men being engaged in sweeping the chippings into the interstices of the stone. On completion, it is coated with a thin layer of ½-in. chippings of similar material, free from dust. Each layer is laid to a camber or gradient of 1 in 25.

The author has found, in carrying out this work, that at times, unless one has been careful in choosing a sufficiently tough stone (and in some cases the cost prohibits this), the stone is broken and crumbled in the process of consolidation by steam rolling; to obviate this, a little binding material in minimum quantity is spread over the metal and slightly watered. Too much attention cannot be given to the spreading of the stone, which really requires great care and skill, as the evenness of wear of the surface greatly depends upon uniform spreading.

In Birmingham the city engineer pays a small bonus to the spreaders; this method works exceedingly well, as there is competition among the men, and only the ablest men are selected for the work. Great care must be taken to see that very little water is used, as there is a tendency on the part of rollermen to use as much as possible, to expedite rolling operations. The loading of this stone into the carts is done with forks, but in a district formerly under the author's supervision, when carting stone on to a site and tipping it close to the spreading, a difficulty was experienced owing to a thorough turning over of the material being impracticable. This was remedied by tipping the stone on to concrete mixing boards, thereby ensuring that it was properly turned, and so obviating any chance of having larger stones in some parts of the road and smaller ones in other parts, besides preventing all the dust, etc., from settling at the bottom.

The method of recoating is to scarify the crust of the old road, regulating the old material, and then applying a 3-in. coat of new metal. Generally speaking, there are two ways of repairing a macadam road, patching or recoating the whole surface. As soon as any potholes or uneven wear appears it should be attended to immediately, the cause ascertained and remedied, and the necessary repairs undertaken. If repairs are delayed it generally means that in a very short time the recovering of the whole surface is necessary, which adds considerably to the cost of repair. Any road, the crust of which is weak, will very soon become bumpy. It is most difficult to keep the surfaces of roads in good condition, owing to the various statutory authorities, such as gas and water companies, interfering with them; also by reason of the fact that in most of the main roads in this city there is a tramway track, and in many parts the sides between the track and the channel is constructed in macadam. This requires constant attention, owing to the traffic causing a rut to form next to the paving. Macadam roads are also being considerably damaged by motor 'bus traffic, and in comparing the repairs to a certain road prior to 'buses running with a corresponding period afterwards, the cost was found to be practically trebled. These motor vehicles do a vast amount of damage, particularly in roads not constructed to sustain their weight and destructive influence.

Tar-Spraying.—In treating road surfaces by the application of tar, the author has found that the life of the roads is prolonged, and also the dust nuisance reduced to a minimum. The chief object is to secure a deep penetration of tar below the surface, so that the metal may be kept together, and a road treated properly in this manner should have the appearance of a tarred-macadam road.

Last year, in Birmingham, 1,771,515 super. yds. of roads, comparable with a length of over 134 miles, were tar-sprayed. The major portion of this work was done by six 1,000-gallon machines, hauled by steam rollers, the cost per super. yard being just under a penny.

To get the best results from tarring, the surface must be thoroughly clean and dry, it being a waste of time and money to treat the surfaces of roads with tar when in a bad condition. The author has observed many failures owing to this alone, and thinks that it is obvious that by tar-spraying a bad road it cannot be converted into a good one.

Tar-spraying should be carried out in a methodical manner, all roads coated or reconstructed in the fall months being tar-sprayed in the early spring, and again, if necessary, in the early autumn. Hills having a steep gradient should be specially gritted if tar is applied to the surface.

Sett Paving.—The author is of opinion that the following describes the most serviceable form of paving for heavy traffic: 5-in. or 6-in. setts laid upon a foundation

consisting of Portland cement base concrete, 9 in. thick (6 to 1), on which is placed a bedding of slightly damped cement and sharp sand, free from silt or loam, to a thickness of 1 in. The paving should be laid before the concrete becomes too hard, when sufficiently damp or mellow enough for the 1-in. feed to unite with it. The setts should be damped with a rose water can, and then grouted with a mixture of 3 of sharp sand to 1 of cement, and rammed as soon after as possible, the whole forming a 16-in. seal of solid mass. Great care must be taken to see that the whole of the materials are thoroughly mixed and of the best quality. No traffic should be allowed over the paving for at least ten clear days.

Both cement and pitch have been used for grouting sett paving, but the author favors the former in all cases where possible, although, to meet present-day requirements, pitch grouting has certain advantages inasmuch as roads finished in this manner can be opened to traffic immediately after completion. There is also less tendency for mud to collect on this kind of grouting, which, however, must be skilfully handled to ensure the proper proportion and correct mixing of the ingredients. The method adopted by the writer is to use a grouting mixed to the following proportions: 2 to 3 gallons of creosote oil and 1 gallon of coal-tar added to every 1 cwt. of pitch. (The quantities of oil and tar being determined by the nature of the pitch.) The joints of the setts having been filled about half way up with ⅜-in. or ¾-in. pea ballast or shingle, and then rammed. Great care must be taken to see that this racking is thoroughly dry. The pitch mixture is then poured from a spouted pail into the corner of the setts (this prevents surplus being left on the top), to about half their depth, and the remainder of the joints filled up with racking as before. Sweep with hard broom and squeegee over the whole surface with the pitch mixture as quickly as possible, so as to leave the smallest accumulation on the top. On no consideration should this work be done other than when atmosphere and materials are in a perfectly dry state.

Perhaps here it might be of interest to mention a particular form of paving in which the author is concerned, which consists of specially dressed 5 in. wide by 4 in. deep Grey Royal setts, laid on a concrete foundation. The contractors were called upon to replace a considerable number of setts with broken corners. The stones were paved when wet on bedding which was more than damp, and when the stone was surface dry, boiling pitch grout was poured into the joints, with the result that it attacked the shakes or flaws in the setts, generated steam in them, and this, acting as a wedge, slightly detaching the flaw or shake portion of the sett. Under heavy continuous traffic it became wholly detached, pulverized, and peeled out. The author is of the opinion that had this work been completed with pitch grouting in dry weather this would not have happened, or, under the above circumstances, had cement and sand instead of pitch been used for grouting.

In Birmingham the standard size of setts used is 4 in. by 4 in. by 5 in. deep, laid with a crossfall of 1 in 45 from the crown of the road to channel, and in straight diagonal courses, meeting in the centre at an angle of 90 deg., with the apex pointing downhill, at an angle of 45 deg. with the channel where the kerbs are parallel. The setts are paved on a 1-in. bed of local sand grouted with a proportion of 5 parts of clean sharp sand to 2 parts of cement. The concrete bed is 7½ in. in depth, the ballast for it consisting of clean, non-porous blast-furnace slag with such an admixture of sand sufficient to fill up the interstices of the stone. After completion, a layer of clean sand is spread over the whole surface, and no traffic allowed over it for three weeks.

In this district the most suitable material for paving streets of steep gradients traversed by heavy traffic has proved to be "grit-stone," the steepest gradient paved with this material being 1 in 11. Care should be taken to see that this class of paving is constantly swilled with water so as to prevent an accumulation of mud and dirt on the surface, and if this has proper attention, complaints of slipperiness are practically unknown. In London and other cities specially dressed 5 in. wide by 4 in. deep Grey Royal setts have been laid on steep gradients, with very close joints, with much success. . . .

Cleansing.—It is obvious that road surfaces need systematic cleansing, gritting and watering, but the author would like to emphasize the trouble that has been experienced in regard to sweeping newly constructed water-bound macadam roads, for, if careful attention is not given to this matter, the binder will soon be removed. In a former district under the author's control, machine sweeping brushes were not used on water-bound macadam surfaces.

The watering of streets in any city is also of great importance, especially as there is now so much motor traffic on the roads. The author had steam motors fitted with tanks, and has found that this method is much more economical and effectual than horse-drawn water carts. These machines were fitted with interchangeable bodies, so that the motors, when not engaged for watering, could be utilized for carting stone or any other materials. In addition to these machines, a steam motor vacuum extractor was used for emptying gullies, and a considerable saving was effected, as compared with ordinary gully vans, besides being more hygienic and saving that splashing which invariably takes place when gullies are being emptied.

UNION OF CANADIAN MUNICIPALITIES.

As announced in our columns some little time ago, the 14th annual convention of the Union of Canadian Municipalities will be held in Sherbrooke, P.Q., on August 4th, 5th and 6th. A comprehensive program has been arranged, special provision being included for opportunities of discussing the numerous questions which will be presented by prominent municipal men from various parts of the Dominion. The aim of the Union, which is to afford municipal men a practical means of learning at first hand up-to-date methods of municipal government from men of experience and of affording also an effective link of municipal union and co-operation against influences adverse to the interests of the people, is certainly to be upheld and encouraged.

Among the various subjects that will be brought up for consideration are the following:—

Building Laws, Smoke Abatement, the Housing Problem in Cities, Municipal Reference Library, Playgrounds, Street Lighting, Taxation and Finance, the Wants of Rural Municipalities, Billboards and Posters, the City Manager Question, Public Libraries, Motion Picture Theatres, Street Cleaning, Water Rates, City Publicity.

The general contractors in the city of Montreal have recently formed an organization with the following officers:—President, Mr. J. P. Anglin, of Anglins, Limited; vice-president, Mr. E. G. M. Cape, of E. G. M. Cape, Limited; secretary-treasurer, Mr. W. Clement Munn, of the Atlas Construction Company, Limited; directors, Messrs. W. D. Ross, of Church, Ross and Company; Guy Boyer, of the Laurentian Construction Company; Rene Lessard, of T. Lessard, and C. Ekin, of the Geo. A. Fuller Company, Limited.

THE CALCULATION OF END AREAS.*

By E. S. M. Lovelace, B.A.Sc., M.Can.Soc.C.E.,
Civil and Consulting Engineer, Montreal.

THE following is a method of calculating end areas without any reduction of elevations or plotting of cross-sections, using direct the notes as taken in the field, thus effecting a great saving in time, giving increased accuracy, and at the same time reducing to a minimum the liability to error.

General Proposition.—Let $P_0P_1P_2P_3P_4P_5$, Figs. 1 and 2, be any polygonal figures and OX, OY any two lines at right angles to one another, and let the distances $a_1a_2a_3$.... represent the horizontal distances of the points $P_1P_2P_3$.... from the vertical lines OY, which in the examples given coincide with the sides P_0P_5.

Let $h_0h_1h_2h_3$....be the vertical distances of the points $P_0P_1P_2P_3$....from the lines OX giving the + sign to the distances below, and the — sign to those distances above

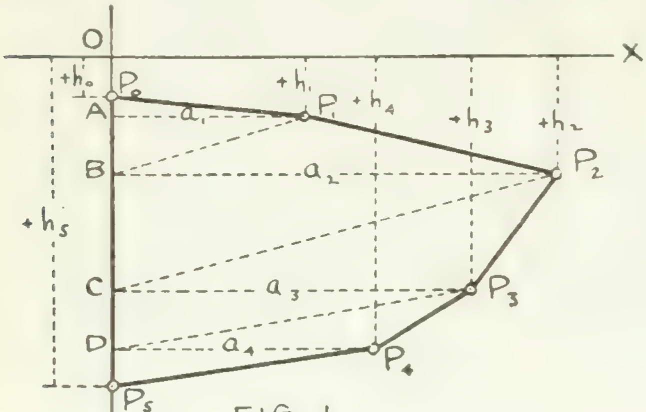


FIG. 1

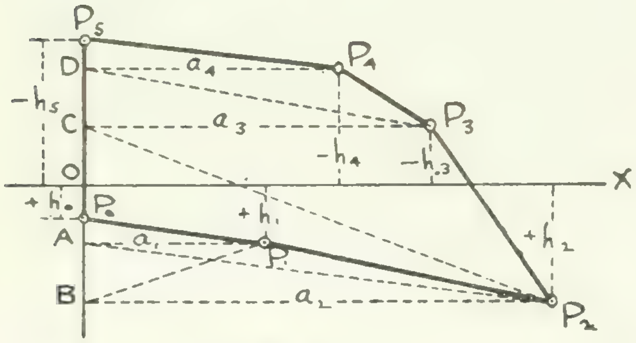


FIG. 2

OX. Then, the areas of the polygons $P_0P_1P_2P_3P_4P_5$ will be given by taking one-half of the algebraic sum of the products found by multiplying consecutively each horizontal distance $a_1a_2a_3$....by the algebraic difference between the ordinates of the points coming immediately after and before such horizontal distance: that is area of the polygon $P_0P_1P_2P_3P_4P_5$ for Fig. 1 will be

$$\tfrac{1}{2}\left[a_1(h_2—h_0) + a_2(h_3—h_1) + a_3(h_4—h_2) + a_4(h_5—h_3)\right]$$

and for Fig. 2

$$\tfrac{1}{2}\left[a_1(h_2—h_0) + a_2(—h_3—h_1) + a_3(—h_4—h_2) + a_4(—h_5 + h_3)\right]$$
$$\text{or } \tfrac{1}{2}\left[a_1(h_2—h_0) — a_2(h_3 + h_1) — a_3(h_4 + h_2) — a_4(h_5—h_3)\right]$$

The proof of the foregoing is easily seen, for drawing the horizontal dotted lines AP_1, BP_2, CP_3, DP_4 and the diagonal dotted lines BP_1, CP_2, DP_3, then for Fig. 1:

$\tfrac{1}{2}a_1(h_2—h_0) = \tfrac{1}{2}a_1BP_0 = \tfrac{1}{2}a_1(BA + AP_0) = \tfrac{1}{2}a_1BA + \tfrac{1}{2}a_1AP_0 = \text{area } BP_0P_1$;

$\tfrac{1}{2}a_2(h_3—h_1) = \tfrac{1}{2}a_2CA = \tfrac{1}{2}a_2(CB + BA) = \tfrac{1}{2}a_2CB + \tfrac{1}{2}a_2BA = \text{area } CBP_1P_2$;

$\tfrac{1}{2}a_3(h_4—h_2) = \tfrac{1}{2}a_3DB = \tfrac{1}{2}a_3(DC + CB) = \tfrac{1}{2}a_3DC + \tfrac{1}{2}a_3CB = \text{area } DCP_2P_3$;

$\tfrac{1}{2}a_4(h_5—h_3) = \tfrac{1}{2}a_4P_5C = \tfrac{1}{2}a_4(P_5D + DC) = \tfrac{1}{2}a_4P_5D + \tfrac{1}{2}a_4DC = \text{area } P_5DP_3P_4$ and the sum of these equals the whole area $P_0P_1P_2P_3P_4P_5$.

For Fig. 2 the proof is similar, for using the minus signs for the ordinates (corresponding to a fill or embankment) then

$\tfrac{1}{2}a_1(h_2 — h_0) = \tfrac{1}{2}a_1BP_0 = \tfrac{1}{2}a_1(BA + AP_0) = \tfrac{1}{2}a_1BA + \tfrac{1}{2}a_1AP_0 = + \text{area } AP_0P_1P_2$;

$— \tfrac{1}{2}a_2(h_3 + h_1) = — \tfrac{1}{2}a_2(CA) = — \tfrac{1}{2}a_2(CB—BA) = — \tfrac{1}{2}a_2CB + \tfrac{1}{2}a_2BA = — \text{area } ACP_2$.

$— \tfrac{1}{2}a_3(h_4 + h_2) = — \tfrac{1}{2}a_3BD = — \tfrac{1}{2}a_3(BC + CD) = — \tfrac{1}{2}a_3BC — \tfrac{1}{2}a_3CD = — \text{area } CP_2P_3D$;

$— \tfrac{1}{2}a_4(h_5 — h_3) = — \tfrac{1}{2}a_4CP_5 = — \tfrac{1}{2}a_4(CD + DP_5) = — \tfrac{1}{2}a_4CD — \tfrac{1}{2}a_4DP_5 = — \text{area } DP_3P_4P_5$,

and the algebraic sum equals the whole $P_0P_1P_2P_3P_4P_5$.

To adopt the above conclusions to field work so as to obtain direct from the level notes the areas of the cross-sections as taken:—

The horizontal line OX corresponds to the height of instrument and the line OY to a vertical line at centre.

The ordinates $h_0h_1h_2h_3$....are the rod readings taken at various points on the section and the horizontal distances $a_1a_2a_3$....the corresponding distances right or left of the C.L.

In the field book these are best noted in the form of a fraction, as shown on the sample page, the numerator being the rod reading, the denominator the corresponding distance:

The areas to the right and left of the centre line are calculated (as they are so taken in the field) separately and their sum gives the total area of the section.

The horizontal distances to the left could of course be given the minus sign and exactly the same final result would be obtained, but in practice it is simpler to imagine the left half section as being drawn on the transparent left page of a book, so that when this page is turned over the left half section would be superimposed upon the right on the right-hand page below, the centre line being represented by the line where the pages join. Thus all the horizontal distances, whether to right or left, can be given the plus sign. Taking the example at the head of the sample page, this section, if plotted, would appear as under.

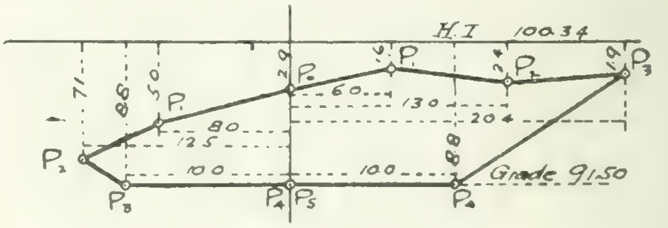


FIG 3

By the formula

area right $= \tfrac{1}{2}[\,6.0(2.4—2.9) + 13.0(1.9—1.6) +$
$\quad + 20.4(8.8—2.4) + 10.0(8.8—1.9\,]$
$\quad = \tfrac{1}{2}[—6.0,0.5 + 13.0,0.3 + 20.4,6.4$
$\quad + 10.0,6.9)$ .... = 100.23

area left $= \tfrac{1}{2}[\,8.0(7.1—2.9) + 12.5(8.8—5.0) +$
$\quad 10.0(8.8—7.1)\,]$
$\quad = \tfrac{1}{2}(8.0,4.2 + 12.5,3.8 + 10.0,1.7)$.... = 49.05

∴ Total end area 149.28

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In working out these areas in the field book the rod readings or ordinates can usually be subtracted mentally and their difference at once jotted down (with the proper sign + or — affixed), as shown on the marginal page.

Should it be found impossible to complete the section with a single height of instrument, proceed as follows: Suppose a section on side hill.

Then, if there be but one or two sections requiring a change in the height of instrument, it would only be necessary after setting up, to find on the upper side the

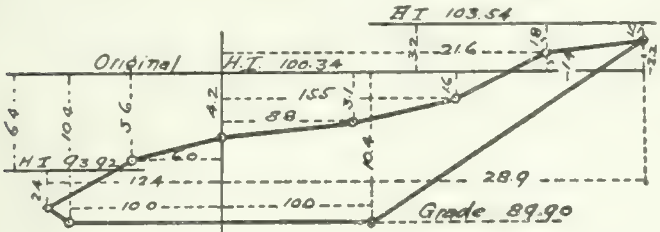


FIG. 4

difference 3.2 between 103.54 the new H.I. and 100.34 the original height, for then the rod readings as taken, subtracted from 3.2, would give the proper readings —1.4 and —2.2 referred to the original H.I.

On the lower or left-hand side of the section the new H.I. 93.92 being lower than 100.34, the original height, their difference 6.4 must be added to 2.4, the rod reading as taken, giving for this left side referred to the original H.I. a reading of 8.8.

If, however, there are a number of consecutive sections requiring various changes as above, it would be better perhaps to enter on another page of the level book, under their respective H.I., the rod readings as taken, and then on the marginal page before using such for calculating the end areas reduce them as shown above to the original H.I. by adding or subtracting the constant difference.

The original sections could then be completed by bringing back these corrected readings and the section for such a cross-section as that illustrated above would appear in the level book as shown in Table I.

TABLE I.

Station		C. or F.	B.S.	H.I.		F.S.	Elevation	Grade
				100.34				
	R	+12.[illegible]		[illegible] / 8.8	1.[illegible] / 15.5	See page	[illegible] / 21.[illegible]	[—2.2 / 28.9]
40		+ 6.2	4.2 / [illegible]					89.90
	L	+ 1.[illegible]			[illegible].6 / 6.0	See page.	[[illegible] / 12.4]	

The resulting end area would then be as already shown:

area R = ½ [8.8(1.6—4.2) + 15.5(—1.4—3.1) + 21.6(—2.2—1.6) + 28.9(10.4 + 1.4) + 10.0(10.4 + 2.2)]
= ½ [—8.8,2.6 — 15.5,4.5 — 21.6,3.8 + 28.9,11.8 + 10.0,12.6] .... = 146.15

area L = ½ [6.0(8.8 — 4.2) + 12.4(10.4 — 5.6) + 10.0(10.4—8.8)]
= ½ [6.0,4.6 + 12.4,4.8 + 10.0,1.6] .... = 51.56

∴ Total end area 197.71

TABLE II.

Station		C. or F.	B.S.	H.I.		F.S.	Elevation	Grade	H.I. to Grade	Calculations, Remarks	End Areas Exc'v'n	End Areas Emb'km't
				100.34						Road bed 20 ft. Exc [illegible] ft. Bank		
	R	+6.9		[illegible] / [illegible]	[illegible] / [illegible]	[[illegible] / 20.4]				$\frac{-6.0,0.5+13.0,0.3+20.4,6.4+10.0,6.9}{2}$		
41		—5.9	2.9 / 0					91.50	+8.8		149.3	
	L	—1.7		[illegible] / 8.0		[[illegible] / [illegible]]				$\frac{+8.0,4.2+12.5,3.8+10.0,1.7}{2}$		
	R	+3.7		[illegible] / [illegible]		[[illegible] / [illegible]]				$\frac{[illegible]}{2}$		
41+40		+2.9	0.1 / 0					91.30	+9.0		65.2	
	L	+0.7		[illegible] / 6.0		[[illegible] / [illegible]]				$\frac{+6.0,2.2+11.0,2.3+10.0,0.7}{2}$		
41+62		0.0		Grade				91.19			0.0	0.0
	R	[illegible]				[[illegible] / [illegible]]				$\frac{[illegible]}{2}$		
42		—[illegible]	12.1 / 0					91.00	+9.3			73.2
	L	—5.4		14 / 9.0		[[illegible] / 16.1]				$\frac{+9.0,2.6-16.1,5.0-8.0,5.4}{2}$		
T.P.			[illegible]	[illegible]		12.06	88.28			On rock 40 ft. Right of 42		
	R	[illegible]		[illegible] / [illegible]		[[illegible] / [illegible]]				$\frac{-9.0,1.6-12.5,4.0-8.0,3.0}{2}$		
42+60		—4.6	[illegible] / 0					90.70	—1.6			127.8
	L	—6.5		[illegible] / 5.[illegible]	4.0 / [illegible]	[4.0 / [illegible]]				$\frac{+5.0,1.9+10.0,1.8-17.7,6.5-8.0,6.5}{2}$		

Table II. is a sample showing manner of keeping the field notes and the method of calculating the end areas direct from these notes as taken.

The section shown in Table III. is on side hill, embankment to the left, excavation to the right, the grade point being as shown 2.5 feet to the right. This must be taken into account in making the calculations so as to keep the excavation and embankment areas separate from one another.

TABLE III.

Station	C. or F.	B.S.	H.I.	F.S.	Elevation	Grade
			89.12			
T.P.		9.16	97.52	0.76	88.36	
			Grade			
R	+4.0		$\frac{7.3}{2.5}$ $\frac{4.2}{6.5}$	$\left[\frac{3.3}{16.0}\right]$		
43+50	0.4	$\frac{7.7}{0}$				90.25
L	−2.2		$\frac{8.1}{6.4}$ $\left[\frac{9.5}{11.3}\right]$			

Thus, excavation area to the right is given by

½ [2.5(4.2—7.3) + 0.5(3.3—7.3) + 16.0(7.3—4.2) + 10.0(7.3—3.3)]

= ½ [—2.5,3.1—6.5,4.0 + 16.0,3.1 + 10.0,4.0] = + 27.9

There would then be to the right in embankment the small area given by 2.5(7.3—7.7)½ = —0.5 and this would have to be added to the embankment area to the left given of course by

½ [+6.4,1.8—11.3,0.8—8.0,2.2] = —7.6 that is a total area in embankment for the section of — 8.1.

It might, however, be considered less confusing in such cases to consider the vertical line as being placed at the grade point instead of at the centre of the section and then all the area to the right of this point would be in excavation and all to the left in embankment.

This would simply mean that in applying the method all horizontal distances taken to the right would be reduced by 2.5 feet and all distances to the left increased by the same amount, that is, area right would

= ½ [4.0(3.3—7.3) + 13.5(7.3—4.2) + 7.5(7.3—3.3)]

= ½ [— 4.0,4.0 + 13.5,3.1 + 7.5,4.0] = in excavation 27.9 as before, and area left would

= ½ [2.5(8.1 — 7.3) + 8.9(9.5 — 7.7) + 13.8(7.3 — 8.1) + 10.5(7.3—9.5)]

= ½ [+ 2.5,0.8 + 8.9,1.8—13.8,0.8—10.5,2.2] equal as before to a total area in embankment of 8.1.

MONTREAL WATER AND POWER COMPANY

The annual report of the Montreal Water and Power Company for the year ending April 30th, 1914, shows a gross revenue of $[illegible], an increase of seventeen per cent. over the previous year. The net operating profit, after paying all expenses, maintenance and bond obligations, was $208,000.

The first half of the new reservoir will be available for use by next September, and the remainder will be ready in a few months thereafter. Mr. Edwin Hanson, the president, stated that the filtration plant continues to be operated in a most satisfactory manner, and that the report of the company's experts indicates that it performs its work with great efficiency. It is intended to increase the capacity of the filtration plant as soon as possible.

A new transformer house has been erected at the main pumping station. It is intended to duplicate the electrically-driven pumps at the Clark Avenue station, and to install a new and large force main from the lower pumping station to the northern territory, eventually communicating with the reservoir in Outremont.

CONCRETE ROAD MAINTENANCE AND COSTS.

At the National Conference on Concrete Road Building, held in Chicago in February last, one of the committee reports dealt with the method and cost of repairing and maintaining concrete roads. This committee reported as follows through its chairman, Edw. N. Hines.

Maintenance work in Wayne County consists in filling the open expansion joint on the roads first built before the development and use of the armor joint, and in the filling with a mastic such longitudinal and transverse cracks as have developed.

A crew consisting of seven men and a team, provided with a tar kettle, is utilized for the work. The foreman is paid $5 a day, the team and driver $5, the "tar man" $3, two laborers $2.50 each and two others $2.25 each. The tools used consist of two wire bristle brooms, a wheelbarrow, a couple of shovels and a tar bucket with a round spout. Tarvia X is now used exclusively. A lighter grade was first tried out, but did not give such permanent results as the heavier grade. Two men are utilized to sweep all cracks clean with the wire brooms, after which the man with the tar kettle fills the cracks with the tar, which is heated to about 225° F. An excess of tar is poured in so that it extends an inch or so beyond the edge of the crack. It is then allowed to stand in the crack for a few minutes to prevent it from "bubbling" out in case the sand is wet. The sand, which should be dry and coarse, is spread with a shovel over the crack and into the tar, and the whole is left for traffic to iron out. The excess tar and sand is worn away rapidly, leaving a smooth, even surface, in passing over which no jolt is apparent.

The work is preferably done on hot, dry days. It has been suggested that the better time to handle this work would be in the late fall when the cracks would be open the widest due to contraction, but the results we have secured in the summer months have been so satisfactory that we have not tried out the latter plan. The small pit holes which are due simply to some foreign substance like clay, wood or some fragment of inferior rock which might chance to be a part of the aggregate, are treated in the same manner. As to the cost of this method, the report contains figures covering 10 pieces of road aggregating 10 miles, the cost of repairs for which, including tar, labor and sand, amounted to $1,300.50 from October, 1912, to October, 1913. Adding a percentage to cover engineering, inspecting, depreciation of machinery and building and other expenses, a total of $1,450 was obtained. The greater part of this mileage was treated for the first time.

The report dealt also with treating the entire surface of a road where the concrete from any cause had not stood the wear. Several pieces of road had not been built up to the standard of the balance of the construction and required surfacing. Others were rough, having been laid in cold weather and opened for traffic before the concrete had thoroughly hardened. The method of repairing one of these is worth noting. The road was first swept by a street sweeper, which was followed by men with wire brooms. About ½ gal. of bitumen to the square yard was used, and the whole covered with coarse sand and rolled with a 10-ton roller. This repair was made early in the summer and was not touched in any manner for a period of two years. By this time it had scaled off in spots quite badly, and was gone over again in the summer of 1913, using Tarvia X and a washed roofing gravel about ¼ in. in size.

WIND LOADS ON BUILDINGS.

THE determination of the distribution of wind loads on buildings has been a subject of a series of tests carried out by Prof. A. W. Smith, and concerning which several articles have been published by him during the past two years. He first obtained data on structures without floors between ground and roof—mill-buildings. The results obtained from these tests indicated that the common assumption in regard to wind loads did not come very near to the actual conditions. The summation of his results in this direction were presented in a paper before the Western Society of Engineers in October, 1912. Since that time Mr. Smith has extended his researches to include larger structures, such as train-sheds and drill halls, the results of which tests were presented several months ago to the same society and appeared in its Journal for April, 1914. From it the following points are reproduced:—

As a model a roof of semi-circular section, 6 ft. span and 10 ft. long, was constructed and covered with tin. This roof was mounted on walls 5 ft. high, made of 2 x 6-in. lumber, tongued and grooved. After each set of observations, the roof was lifted and 6 in. of the walls taken off. The use of tongued and grooved stuff made the walls comparatively tight, and also made them somewhat stiff when an end or side was omitted in the course of the tests. At a middle section of the building, holes were bored about 1 ft. apart in the walls and roof, the row extending from ground to ground. These holes were about ½ in. in diameter, and in the roof a short nozzle was soldered on the inside. A series of holes at various levels were also carried completely around the house.

The author describes in detail the pressure-recording instruments and the method of taking the observations, as well as the method of calibrating pilot tubes.

After the readings were taken the pressure or suction inside the house was standardized, and the result was reduced, first to pds. per sq. ft. and then to that for a velocity of 10 mi. per hr. The pressure or suction inside the house was found to be variable, partly because, in a somewhat gusty wind, the pressure condition in the house was found to lag behind the velocity changes outside, and also because small changes in the direction of the wind caused great changes in the conditions of exposure of the various leaks, which were not, of course, symmetrical around the house.

Observations were taken while the house was thoroughly caulked, so that the conditions were nearly ideal. Readings were also made on the model with different sides and ends omitted, as well as with portions of the walls removed. The paper included diagrams of measurements taken at the various observations with the model under usual different conditions.

Mr. Smith found that the forces on the building with one side open, while greater than for one of the same height with the side closed, did not exceed the proposed units. With the wind in the other direction, the pressure

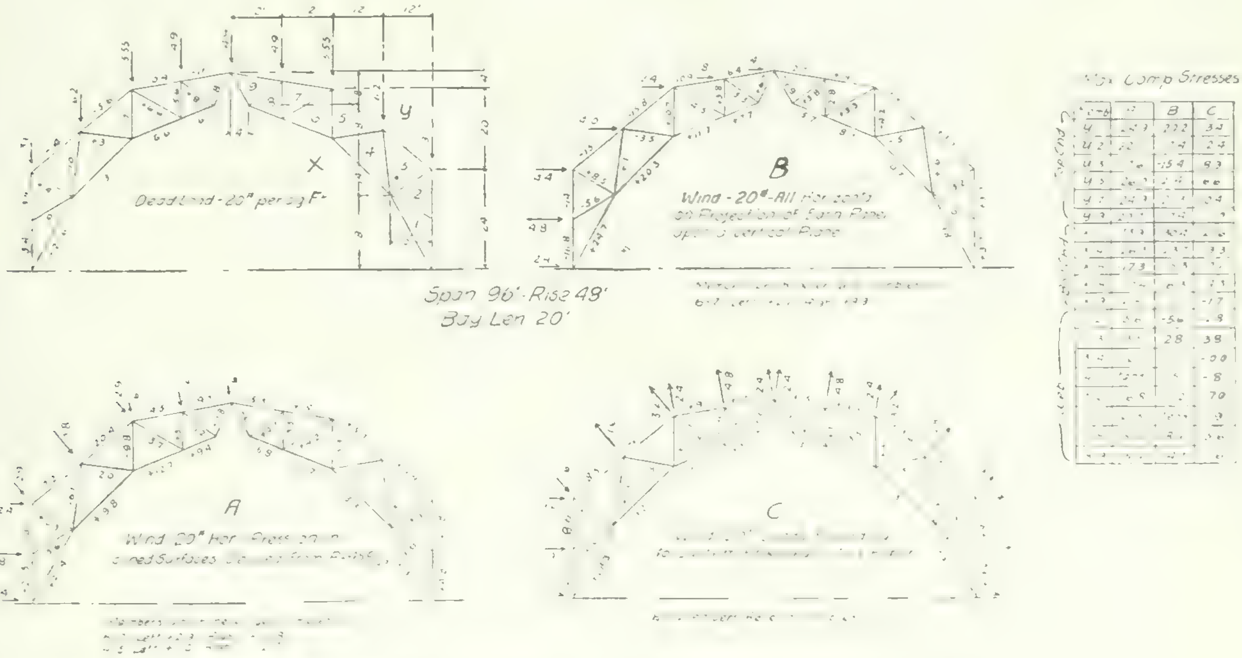


Fig. 1.—Comparison of Stresses in Arch from Different Loadings.

on the closed wall would be increased by a rarefaction inside the house, and the suctions over the roof would be diminished. Observations on the model with both sides removed show that the stresses for this case are less in amount, and nearly the same in distribution as for the closed house. A comparison of the stresses in a very simple two-hinged arch from three systems of wind-loading is shown in Fig. 1. It appears that if the wind loads are as shown by the test described, not only are the stresses assumed to be much too large in most cases, but in two cases they gave tension only in numbers which should be designed for compression. This truss is of exaggerated depth, and in a large truss of ordinary depth the discrepancies would be greater. Such arches are now made entirely of compression sections in most cases, but it would be better to adopt a loading system which makes it impossible to do otherwise. In Fig. 2 are shown the same comparison for a mill building bent. As in the arch, all members received compression from the proposed loadings, while by the common method three of these members would be designed for tension only.

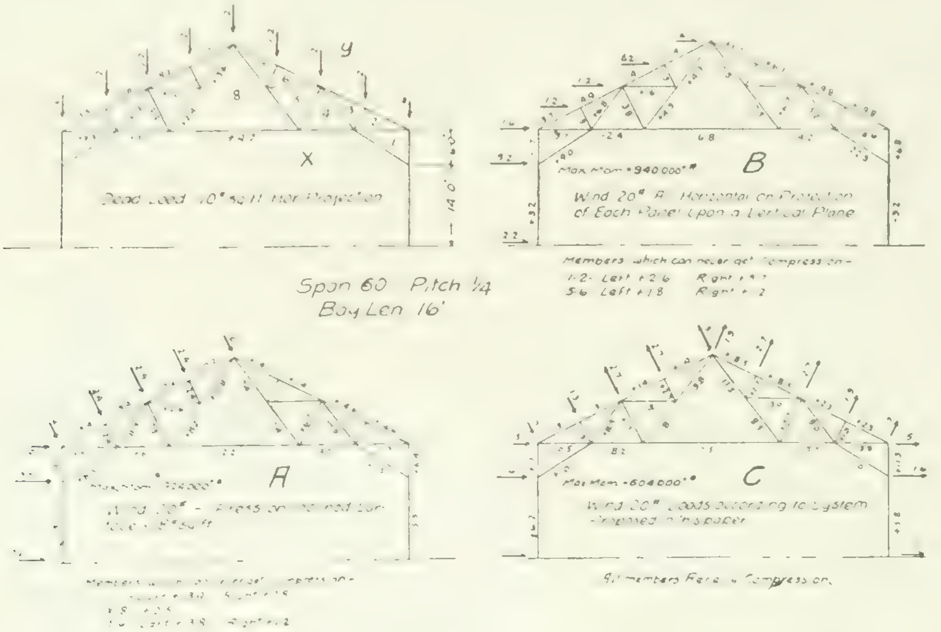
Another experimenter, Mr. A. See, recently read a paper before the Industrial Society of Northern France, "The Wind Pressure on Roofs," relating to experiments

in connection with aeronautics which had raised a good deal of doubt as to the validity of the officially adopted formula for wind pressure against roofs and walls. Abstracts from his paper appeared in the Journal of the American Society of Mechanical Engineers for June, 1914. The results are interesting when considered in connection with the above, and are further abstracted herewith:—

It is usually assumed that the wind pressure on a surface with a plane normal to the direction of the wind is equal to the product of the area of the surface by the square of velocity, multiplied by the co-efficient 0.14.

In the case of a roof it is assumed that the wind moves downwards at an angle of 10 deg. and strikes the roof at an angle $a + 10$ deg., where a is the angle of the roof with the horizon. Under these conditions the pressure is obtained by multiplying the preceding equation by $\sin^2 (a+10)$. This official formula is, however, entirely antiquated and its lack of accuracy is obvious now that the coefficient of resistance of the air is known to be not 0.14, but 0.08. The hypothesis of the wind descending at an angle of 10 deg. is purely arbitrary. The law of sine square has been shown not to agree with experimental data, and finally the formula does not take into consideration the shape and location of the roof.

Experiments have been made recently at the Engineering Aeronautical Battalion of the Italian Army with models of two types of semi-lozenge shaped hangars (Fig. 3, A and B), where the pressure curve and the magnitudes of the pressures, at various points of the profile, are indicated. One sees at once that the pressure curve has nothing to do with either the sine square or simple sine law, or, indeed, with any law based on the angle of incidence. The wind pressures along the frontal surface of the structure rapidly diminish as the curve inflects, and become zero some time before the tip of the lozenge is reached; moreover, they become negative all along the rear surface, a fact which is not shown by the formula. There is, therefore, quite an important partial vacuum, independent of the curvature of the structure, and it appears that the wind pressure on each element depends not so much on the angle of incidence at that point as on the location of that particular element with respect to the rest of the structure.



Max Comp Stresses

Mem	A	B	C
X-1	215	225	10
y 2	247	30	25
y 3	242	37	18
y 6	184	86	32
y 7	179	91	7
1 2	tens	tens	50
X 4	26	71	86
X-8	ten	21	28
2 3	-35	16	-24
3-4	136	140	68
4 5	-95	60	22
5 6	tens	tens	-18
6 7	35	-6	-11
5 8	30	-51	-6
7-8	38	39	-79

Fig. 2.—Comparison of Stresses in Mill Building, from Different Loadings.

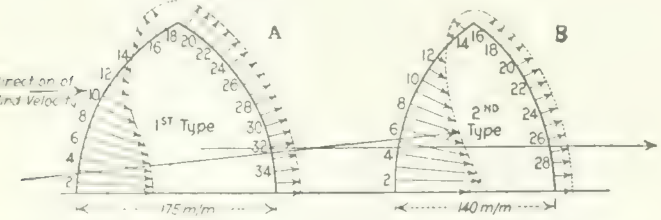


Fig. 3.—Distribution of Wind Stresses on Buildings.

When, however, one comes to the consideration of the question as to which formula would be more acceptable than the old official formula, one finds that while this official formula is incorrect, any other formula which might be derived at the present time would be just as likely to be based on arbitrary assumptions and involve coefficients of doubtful value. Whether the new formula would give better results is somewhat doubtful, while it is a fact that structures built in accordance with the old formula proved to be quite stable. The author, therefore, rather curiously arrives at the conclusion that while the old formula is admittedly incorrect it should still be followed, at least until an absolutely good new formula can be derived.

PROGRESS ON DRY DOCK AT FREDERICTON, NEW BRUNSWICK.

Norton, Griffiths & Co., Limited (Canada), engineers and public works contractors, are building a dry dock of considerable magnitude for the Dominion Government at Fredericton, N.B. The dry dock when completed will be 900 ft. long and 100 ft. in width. Up to the present time about six acres of land in the vicinity of the dock have been reclaimed and about nine acres of hilly ground on the site of a proposed ship-repairing plant to be constructed in connection with the dock, has been cleared to the level of the coping of the dock.

Excavation below coping level is in progress, a total quantity of rock and over-burden of approximately 410,000 cu. yds. having been removed to date.

COMPLETION OF TRACK LAYING ON THE GRAND TRUNK PACIFIC RAILWAY.

THE accompanying photographs are illustrative of the enthusiastic manner in which the last mile of the Grand Trunk Pacific Railway was furnished with steel. As the track-laying outfits from east and west approached each other it was decided to have a race for the finish. The west outfit reached the west end of Mile 111, Willow River, about noon of April 6th, and waited there until 11.30 a.m. of the 7th, when the outfit was ready to start from the other end of the mile. The two track-laying gangs then started simultaneously in a race to reach the stake which had been driven at the middle of the distance. The 0.4 of 1 per cent. grade was in favor of the east crew, but it was not expected that this would make any material difference in the speed of such work. Further, the machine from the east was housed in, but with this exception the two outfits were about the same, both being a modification of the Roberts track-laying machine, fitted with an air-hoist instead of a winch for handling rails. The east machine, however, was using a winch, the air-hoist having gone out of commission.

The east gang, in charge of Phil. Egan, made the half-mile in 42 minutes, while the west crew, under Dan Dempsey, reached the stake in 64 minutes. The chief difference between the methods of the two outfits was that Dempsey's machine laid a rail, moved ahead, stopped to lay another, and so on, while Egan did not stop, but moved slowly ahead. By this latter method the tie-buckers were obliged to carry a tie a very short distance only as compared with the other. While one man could handle a tie, in the west gang two men were required to do it. This method was also responsible for the unnecessary loss of several minutes owing to the locomotive on two occasions progressing beyond the desired point and having to back up.

When the last rail was laid, Mr. Kelliher, chief engineer; Mr. Morley Donaldson, vice-president and general manager; Messrs. Brewer and Meehan, superintendents, and Messrs. Egan and Dempsey, superintendents of track-laying, each drove a spike into it. The ceremonies were then concluded by the presentation of gold watches to the two track-laying superintendents. The event was witnessed by 700 or 800 spectators.

Laying the Last Mile of Track on the Grand Trunk Pacific.

West End Machine Prepared for Race.

East End Machine Coming up to the Finish.

Bringing on the last Rail.

This maximum grade against east-bound traffic of 0.4 of 1 per cent. is a striking feature of the new line through the mountains. Against west-bound traffic there is a maximum grade of 0.5 of 1 per cent. with the exception of a single pusher grade of 1 per cent., 19½ miles in length. The Grand Trunk Pacific Railroad traverses prairie country for a distance of over 922 miles between Winnipeg and Edson, Alta. The elevation at these two points is 767 ft. and 2,984.3 ft. respectively, the difference being in the form of a gradual rise. Immediately west of Edson the line encounters the mountains and in the Yellowhead Pass, a further distance of 123 miles, it reaches an elevation of 3,723.11 ft. Then the elevation drops over 1,200 ft. in the next 45 miles including the 1 per cent. grade referred to above. From this point no grades exceed 0.4 of 1 per cent. in either direction as the line traverses the valleys of the Fraser, Bulkley and Skeena Rivers.

It has been announced that on July 1st, a regular train service will be in operation between Fort George and Edmonton and that the company is expected to extend this service to Prince Rupert by early fall. We are indebted to Mr. S. V. Ardagh, Residency 46, Engineering Department, Grand Trunk Pacific Railway, Fort Fraser, B.C., for the photographs reproduced herewith.

The government at Cape Town, South Africa, has decided to erect a new lighthouse at Cape Point. The old lighthouse, of 2,500 candlepower, has been in existence for half a century, and will be superseded by a most up-to-date dioptric flashlight of 500,000 candlepower. It will stand 300 feet above sea level, and will have a range of 24 miles. The estimated cost is £8,000.

WIRE AND CABLE PLANT OF THE NORTHERN ELECTRIC COMPANY, MONTREAL.

THE new wire and cable plant of the Northern Electric Company, Limited, now nearing completion in the city of Montreal, occupies an area of 178,000 sq. ft. (over four acres). The present plant having been found inadequate, expansion has necessitated the erection of this new structure, which, when completed, will be one of the largest in America for the exclusive manufacture of wires and cables. The E. G. M. Cape & Company, Limited, have the general contract for the building. The foundations for walls and columns are composed of plain and reinforced concrete. In the main building and some of the one-story portions the columns rest on Raymond concrete piles, of which 4,000 have been driven, with an average length of 12 ft. On each group of piles rests a reinforced concrete cap, on which bases for the building columns are placed.

The 6,500 tons of structural steel required for the superstructure were supplied and erected by the Dominion Bridge Company. Bethlehem "H" columns girders and beams were used almost exclusively throughout.

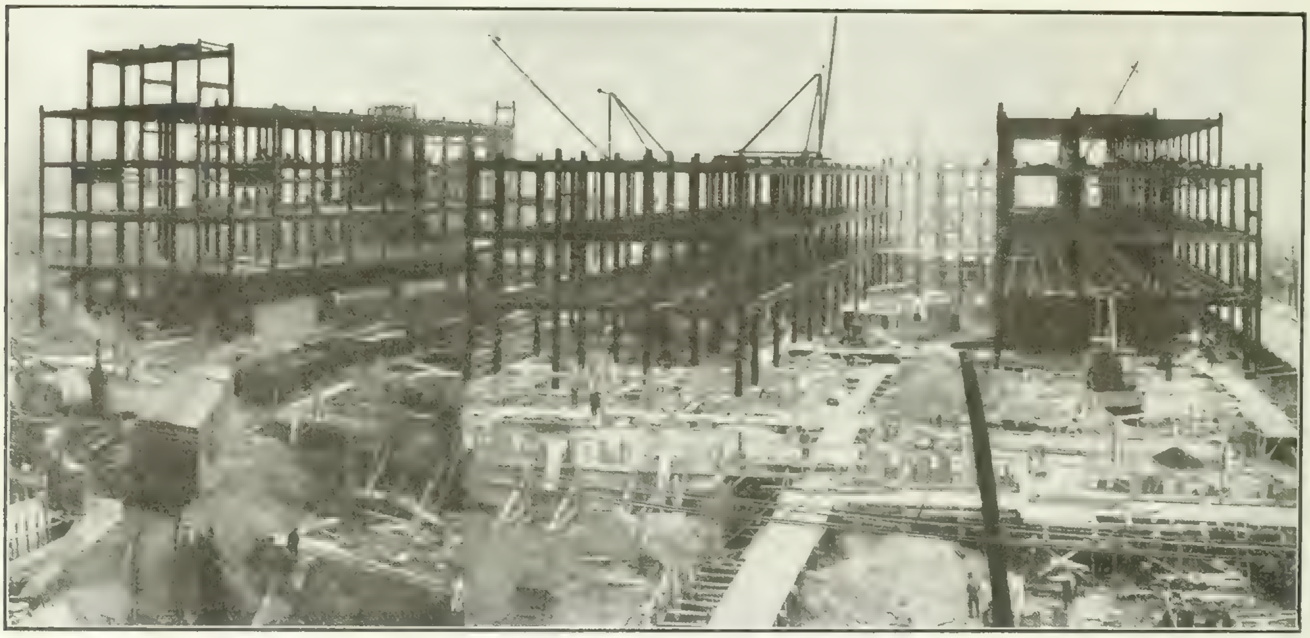
Fireproof construction has been used throughout the entire building. All interior columns are encased in 4¾ inches of hollow terra cotta, and beams in 2⅜ inches. The floors are composed of hollow terra cotta segmental arches with a span of 6 ft. 8 in., and are suitable for a live load of 288 lbs. on the second to seventh floors and 150 lbs. on the eighth floor. A stone concrete fill is poured over the arches, in which wooden sleepers are embedded, and the underflooring is nailed to these sleepers, and over this, the final maple flooring is laid at right angles. The National Fireproofing Company supplied all the fireproofing terra cotta, amounting to 11,000 tons.

The walls are built of Laprairie Plastic Brick, seven millions being used. All the lintels in the courts and on the street sides, together with the architectural ornaments and copings on the street sides, were supplied by the Atlantic Terra Cotta Company, of Tottenville.

The main buildings, shaped like the letter "E," have two main courts, which serve to provide ample lighting facilities for the 500,000 sq. ft. (over 12 acres) of floor space from the interior, as well as the exposed sides on the streets. These courts have sloping roofs of book tile, with large skylights. The G.T.R. and C.P.R. railway tracks run into one court, which has large platforms for shipping and receiving purposes. Each track is provided with a 150-ton Canadian Fairbanks-Morse Company track scale.

There are four travelling electric cranes, one 50-ton, one 20-ton, one 20-ton with 5-ton auxiliary hoist, and one 10-ton all made by the Case Crane Company. The 50-ton crane will be used for handling reels of armored cable, the 20-ton for the lead-covering department, the 20-ton with 5-ton auxiliary for the turbine room, and the 10-ton for the impregnating tank room. The two 20-ton cranes are arranged so that they can pass material to the 50-ton, which will convey it over the railway tracks, or vice versa.

Fire walls, with automatic steel fire-doors on both sides, divide the building into various sections. Each section has a fire and smoke-proof stair tower, with iron stairs at both ends, thus providing ample and safe means of exit in case of fire on any floor. The fire-doors for the whole building were supplied by the Architectural Bronze and Iron Works, and the iron stairs by John Watson & Son, Limited. All windows throughout the building have steel frames with wire glass. Pivoted sections of these windows can be opened with operating chains equipped with fusible links, thus making them self-closing in case of fire. The 95,000 sq. ft. of steel sash required for the factory was supplied by the Trussed Concrete Steel Company, and the casement sash for the offices by Henry Hope & Son, Limited.



New Plant in the Process of Erection: Steel Almost All in Place.

All drains and underground sprinkler mains are being installed by James Ballantyne. The sprinkler and fire hose systems above the first floor level are supplied by H. G. Vogel Company (Canada), Limited, and consist of 6,000 sprinkler heads and fire hose, located at convenient points in the building. These systems are supplied with water from the city mains, steamer con-

nections on the street, and a 1,500-gallon Worthington underwriter's fire pump, which is connected to a 100,000-gallon concrete reservoir and the canal.

Five 6,000 and one 15,000 lb. freight elevators, with a travel of 100 ft. and 25 ft. per minute, respectively, will be used to handle the transfer of material for manufacturing, and two high-speed passenger elevators, travelling at 350 ft. per minute, will be used to serve the general offices of the company, which are situated on the eighth floor of the building. They are being supplied by the Otis-Fensom Elevator Company. This floor has no columns, the roof being supported by steel trusses with large skylights. The absence of columns afford splendid facilities for the laying out of offices to suit the requirements.

A unique point in the design of the building is the storage space secured on the roof of one section by means of paving bricks. This roof is served by means of one of the 6,000 lb. freight elevators.

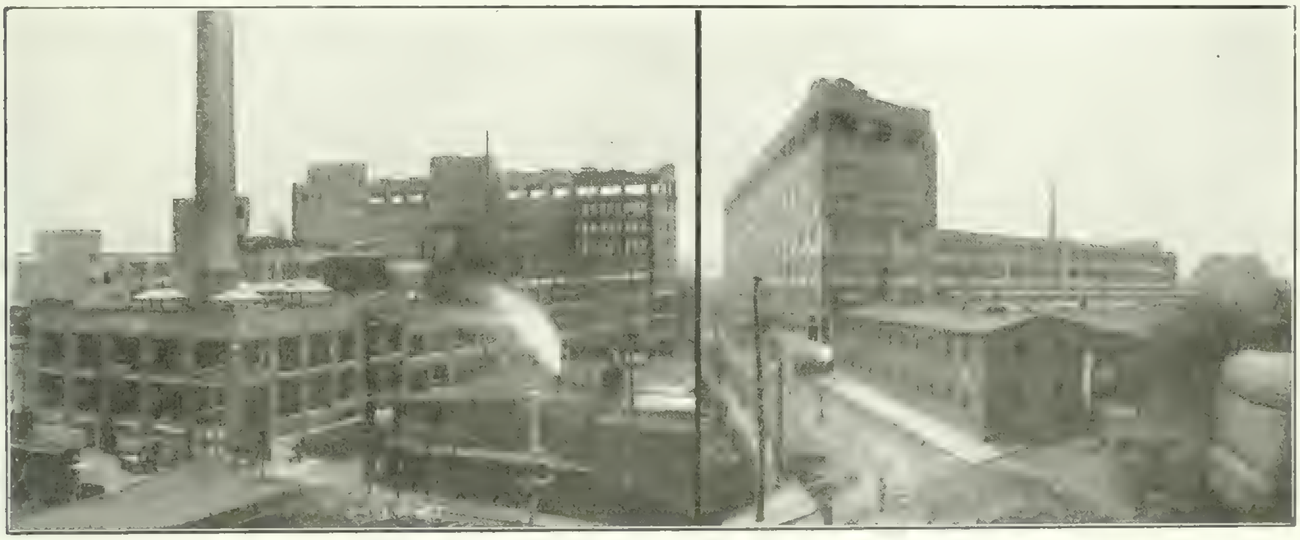
Large intake pipes from the canal supply the reservoir and the water used for condensing purposes. An automobile garage and a wagon court are so arranged that the material can be readily loaded for city delivery without having to cross the railroad tracks.

The building will be heated by a forced circulation hot water system. Exhaust steam from one of the main turbines will be passed through closed heaters. The water will be circulated by means of a 4,000-gallon Alberger single-stage volute pump, directly connected to an Alberger-Curtis steam turbine. The vapors and condensate from the exhaust steam will be carried from the heaters by means of an Edwards air-pump with a tail-pump. This makes a very flexible system to suit the changes in the outside temperature, as the vacuum can be increased in warm weather, thereby creating a lower temperature of the exhaust steam and decreasing the amount of steam required by the turbine as the vacuum increases. In extreme cold weather the turbine can exhaust into the heater at atmospheric pressure, and thus increase the quantity and temperature of the stream. When running two turbo-generator units in parallel, one turbine can run condensing, while the other exhausts into the heating system, and its load can be varied to suit the amount of steam required for heating purposes. The power plant equipment for this heating system is in duplicate, either one of the units being large enough to take care of the whole system. The enclosed heaters mentioned above were built by John McDougall Caledonian Iron Works, Limited.

The water required for the house service system and for manufacturing purposes will be pumped from the 42-in. intake pipe mentioned above by means of Deane motor-driven, single-acting, helical-geared triplex pumps, supplied by John McDougall Caledonian Iron Works Company, Limited.

The Canadian Ingersoll Rand Company are supplying two steam-driven air-compressors, which have a combined capacity of 1,200 cu. ft. per minute.

The power plant is of the most modern design. Coal can be stored in large quantities, and will be transferred to the storage bins over the front of the boiler by means of a Telpher car and clam-shell bucket. Ash-handling equipment takes the ashes directly from ash-shutes under the boilers and delivers them into ash-storage bins, which in turn deliver them into railroad cars or carts for disposal. Ashes can also be handled by means of small cars on an industrial railway running in the basement of the boiler-room. The Telpher car will raise the body of each of these cars off the truck, through a hatchway in the main boiler-room floor, and will carry them over to the ash-storage bin. This method of ash-handling will only be used when it is necessary to overhaul and repair the regular ash-handling equipment.



Two Views, from Different Directions, of the Buildings.

A 225-ft. chimney, built by the Alphons Chimney Construction Company, serves four B. & W. boilers, nominally rated at 650 horse-power, but which will be forced to deliver 1,000 horse-power when necessary. These boilers are fitted with B. & W. chain-grate stokers and superheaters. The exhaust steam and condensate from the heaters, turbines, condensers, and steam-driven auxiliaries are brought to a Warren & Webster feed-water heater, which is capable of raising 107,000 lbs. of water per hour to 210°. From this heater the water is returned to the boilers by means of two Weir boiler feed-pumps, each with a capacity of 6,000 Imperial gallons per hour. General Electric Company Curtis horizontal turbines form the motive power for the generators, and are placed on structural steel stands directly over the Alberger centrifair condensers, thus insuring a high vacuum. The condensers are located over two 42-in. pipes leading to the canal. From one of these pipes the water is drawn by a turbo-volute turbine-driven pump, and

after having passed through the condenser is discharged into the other pipe. Tunnels leading from the turbine and pump-room are used to run the power and lighting circuits, the flow and return pipes of the forced hot water heating system, the house service water lines, and the high-pressure steam lines for manufacturing purposes.

The turbine-room has been laid out for two 2,000 K.W. and two 1,000 K.W. turbo-generators, two 460 K.W. rotary converters and two 75 K.W. turbo-driven exciters. Of these, 1,000 K.W. and one 2,000 K.W. turbo-generators and two rotary converters will be installed now. The generators are 3-phase, 60-cycle, 440-volt, star-wound, with neutral connection brought out to the switchboard. The exciters are 125-volt, and generator voltage will be controlled by Tyrrill regulator.

Air for the ventilation of the generators will be taken from a duct in the foundations of the generators and forced through the windings and air passages by fans integral with rotors. Screens will be provided in the pent-house of this duct to exclude dust, etc.

The connected load will be approximately 550 h.p., d.c. at 115 volts, and 4,000 h.p. a.c. at 440 volts. For the supply of the former, two 460-K.V.A. rotary converters, with necessary transformers and starting switches, will be installed, the neutral being brought out from each transformer bank for the neutral of a 115/230 volt, 3-wire, d.c. system.

The switchboard for the control and distribution of this power will consist of a main board of 25 Blue Vermont marble panels on the turbine-room floor. On this board will be mounted the meters for measurements of outputs of generators and loads on the feeders; also the d.c. bus-bars, both for exciters and d.c. factory load, and control equipment for 25 solenoid operated feeder switches for a.c. distribution. These switches will be mounted on Monson slate panels on a mezzanine floor under the turbine-room floor. The a.c. 440-volt bus-bars and generator switches will also be located here.

Generator switches will be non-automatic, with bell-ringing attachment, and feeder switches automatic, as mentioned above. All feeders will leave the turbine-room in a tunnel, from which they will branch off to the various buildings in 3-in. fibre conduits. These fibre conduits will lead to cable-pits, from which risers of 3-in. conduit will be carried to distributing panels. All a.c. cables will be 3-conductor paper insulated, leaded, direct current cables being single-conductor, leaded. For lighting factory area, 4-light clusters, wired in series-parallel, will be used. As mentioned above, the neutral point of generator windings will be brought out. The lead sheath of the lighting feeder cables will be bonded to the neutral bus and lighting circuits will connect one wire to one of the three conductors, the other to the sheath, giving approximately 266 volts across two lamps in series. Lighting feeder cables will lead to distributing boxes on the third floor of each section, from which circuits will run to the panel boxes on the different floors. Power feeders will run to distributing boxes on the third and fifth floors, from which circuits will run to power loops on each floor.

All wiring except that in general offices will be open conduit. The general offices will have outlets for fans, dictographs, annunciator and telephones, all wiring concealed in conduit. A large number of 3-phase, 60-cycle motors will be used for direct-connected, belt and group drives. L. K. Comstock & Company have the contract for wiring the lighting and power circuits.

An artesian well is being drilled by Wallace Bell Company, Limited, and will be used for drinking water and for manufacturing purposes.

In addition to the fibre protection system, a regular watchman's service system will be installed, so that the building will be patrolled at all times outside of the regular working hours. For the convenience of watchmen and to avoid the use of oil lanterns in the plant, a certain number of electric lights will be kept burning all night to form a pilot system, so that in cases of emergency the workmen in the building can easily locate the fire apparatus and also the exits.

The following features in connection with the building are of interest:—

The total excavation amounts to some 50,000 cu. yds. Over 14,000 cu. yds. of concrete have been used for foundations. 1,500 carloads of building material have been received up to the present time. 100,000 sq. ft. of glazing has been used, and approximately 100,000 sq. ft. hot water radiation service will be required.

The work has been executed under the direct supervision of Mr. E. F. Sise, President of the Northern Electric Company, Limited; Mr. J. D. Hathaway, General Superintendent; Mr. J. S. Cameron, Plant Engineer, and Mr. W. J. Carmichael, Architect.

USE OF POWDERED FUEL.

Fuel economy and the intimately associated problem of smoke abatement are receiving much attention. Among the methods discussed none perhaps is of greater interest than the burning of powdered coal The experiments made in this direction are of especial value to all who are interested in the utilization of peat. The work done by Lieutenant Ekelund in Sweden, according to the Journal of the Canadian Peat Society, has already demonstrated that peat has very great possibilities when used in powdered form. Its composition and physical properties make it in some respects superior to coal for this purpose.

The requirements for best results in burning powdered coal are thus stated by an authority.

(1) Coal must be dried to contain not over 1 per cent. of moisture.

(2) It must be pulverized to a high degree of fineness.

(3) It must be projected into a chamber hot enough to cause instant ignition.

(4) It must be supplied with sufficient air for complete combustion.

The standard of fineness given by the same authority is:—90 per cent. through a 400 mesh screen; 2½ per cent. to 5 per cent. through a 200 mesh screen, and the balance through a 100 mesh screen.

The cost of preparation of coal is variously estimated at from 32½ to 36½ cents per ton, with power at 1½ cents per k.w. hr.

It must be kept in mind that there is present in powdered fuel a certain percentage of extremely fine material, depending on the character of the fuel, its moisture content, and method of pulverization. The character of the flame is materially influenced by this impalpable dust which gasifies instantaneously.

The physical structure of peat is such that a large percentage of very fine powder would be more easily obtainable than in the case of coal, thereby increasing the rapidity of combustion.

Another point in favor of peat powder is the usual high content of volatile matters in peat. There is much divergence of opinion as to the amount of volatile matter required in coal to render it suitable for burning as powdered fuel. The majority of writers seem to think that 30 per cent. of volatile matter is a prerequisite, but some report satisfactory conditions with but 20 per cent. The higher the volatile the larger amount of the combustible will be converted into gas by the mere application of heat, and the more rapid and perfect the combustion. Ontario peats examined contain as high as 60 to 70 per cent. volatile matter, and should produce a highly efficient powdered fuel.

As in the production of peat fuel generally the important question is the removal of the moisture at such cost as to render the fuel economic.

Coast to Coast

Fort William, Ont.—The plant of the National Tube Company at Fort William is completed, and the works have commenced operating.

Montreal, Que.—The Canadian Fire Underwriters' Association is urging the inspection by competent engineers of Montreal's system of fire protection.

Regina, Sask.—The provincial highways commission of Saskatchewan is proceeding with a program of road construction work of a more extensive character than that of the past season.

Weyburn, Sask.—Preparatory work in connection with the laying of steel on the G.T.P. Weyburn-Talmage branch began the first week in June, and it is anticipated that the department will have the metal laid into the city by June 15.

Edmonton, Alta—Edmonton has decided to construct a municipally-owned paving plant at a cost of $37,000. It is to be in operation within 30 days, and it is planned to lay a' least 100,000 square yards of pavement before the close of the 1914 season.

Winnipeg, Man.—While recently in Winnipeg, Mr. David McNicoll, vice-president of the Canadian Pacific Railway company, stated that the company would spend much money this and succeeding years on railroads in the Okanagan Valley, British Columbia.

Kingston, Ont.—A concrete bridge on stone foundation has been completed at Dog Lake, which has been built by the county and Palmerston township conjointly at a cost of $5,000. The bridge is 300 feet long, and has a central iron span 28 feet wide. It is reported as a very satisfactory piece of work.

Vancouver, B.C.—C.P.R. engineers and surveyors left Campbell River recently in two parties working on the preparation of surveys to carry the line of the Esquimalt and Nanaimo Railway northward along the shore of Vancouver Island. One survey party is working south of Campbell River, and one north, the later proceeding along the trail built by the government into the Salmon River Valley. It is stated that the intention of the C.P.R. is to build eventually to the north end of Vancouver Island.

Moose Jaw, Sask.—City Engineer Mackie has at present under investigation 11 gravel pits which have been offered to the city for purchase. The city intends acquiring a gravel pit with a view to using the gravel therefrom for macadamizing the principal residential streets throughout the city. The city engineer states in the course of an interim report to the works committee that, in his opinion, the cheapest method of securing good surfaces is by the use of some sort of macadam, such as gravel screened and graded; and by the treating of this, in order to yield a satisfactory surface, with some patent road material, such as "Rocmac."

York Township, York County, Ont.—At the recent meeting of the Central Ratepayers' Association of York township, a proposal was submitted by a representative of a United States firm of engineers, whereby the firm will construct a waterworks system in the township and guarantee a water supply to the residents at a fixed price per 1,000 cubic feet, the cost of construction to be borne entirely by the firm and the water to be brought a distance of 25 miles and supplied to all houses. If the ratepayers were to construct their own system, however, the company will undertake to supply the water. Further discussion of the scheme will be held at public meetings of the ratepayers before any decision is announced.

Victoria, B.C.—Mr. J. W. Stewart, president of the P.G.E. Railway company, has made a statement to the effect that the company's entire line is now under contract with the exception of about 34 miles. Grading is in progress along the whole right-of-way from Squamish to Fort George and will practically be finished this year. Also before the end of this year, it is intended to put in operation an accommodation train service between Squamish and Lillooet. Mr. Stewart announced further that, within a few weeks, development work will be started on the Coast terminals of the Pacific Great Eastern at Squamish. This will involve large expenditures for the improvement of the harbor and the laying out of the townsite.

Toronto, Ont.—Mr. C. R. Barnes, expert for the Ontario Railway Board, has recently presented to the Corporation Counsel a report upon the Toronto Street Railway. He finds that the seating capacity of Toronto street cars is inadequate, and recommends an increase of over 50 per cent. The present seating capacity of 29,069 during rush hours should be increased by 10,813, half of this number by the beginning of November next, and the rest a year from that date. Many of the cars in use are found to be out of date, and it is recommended that 37 single-truck cars and 71 closed trailers be replaced by new cars approved by the board by the first of November next. An additional 29 cars should be in service on new lines by the same date. In addition to this the platforms should be lengthened on 200 double-truck cars.

Calgary, Alta.—The latest estimate on the cost of the proposed concrete bridge at Ninth Street West across the Bow river at Calgary is $165,000, or $5,000 more than the figure given some time ago, and $105,000 more than the steel bridge that was voted for by the ratepayers some time ago. The by-law upon the subject has been prepared, and it was submitted to the City Council at the meeting held recently, but no action was taken, the proposal being referred to the Finance Committee for consideration. The figures, which have been revised by City Engineer Craig, provide $150,000 for the cost of the bridge and $15,000 for engineering and contingent account. The bridge which the ratepayers voted for when the three bridge by-laws were before the people some time ago, was a steel bridge to go alongside of the present steel Louise bridge. This bridge would cost $60,000.

Victoria, B.C.—Work is progressing in three tunnel shafts in connection with the Northwest sewer at Victoria. The first two are in the portion open in Esquimalt, the third at Sunnyside abutting on the Gorge waters. Preparations are being made to start a fourth shaft at Smith Street; while a considerable amount of work has been accomplished on the Cecilia road tank. At the first shaft, near the sea at McLoughlin point, 160 feet have been pierced to the south and 180 feet to the north side of the tunnel. The excavation from the outfall to No. 1 shaft has been opened for about 2,000 feet, and steps have also been taken to open a drift towards that shaft in order to increase the opportunities to advance this section. At No. 2 shaft about 160 feet north and 180 feet south have been worked, and the junction with the section of tunnel being worked from No. 1 shaft, should be effected in August. From No. 2 shaft the trench on Smith street has been opened about 500 feet, while on Gore, Head and Dunsmuir streets in trench excavation about 1,000 feet have been opened. At Dunsmuir street, the present terminus of the open excavation, a tunnel will be commenced continuing at a considerable depth under that street. It is possible that another shaft will be sunk at the other end to secure a face to work at the tunnel from that section. At the Sunnyside tunnel, No. 3, a drift of about 120 feet has been made. At the Cecilia road tank, which is rendered necessary by the levels of the land to be drained north of the Gorge, the steel is in place, and the concrete floor laid; and the concrete will be poured for the walls in the course of the next few days.

PERSONAL.

R. W. BROCK, Deputy Minister of Mines, Canada, will, as announced, spend a portion of the summer on a geological study of the Bulkley Valley, B.C.

WM. C. ROWSE, B.Sc., M.E., has been appointed professor of mechanical engineering at the University of Manitoba. Prof. Rowse is a graduate of Purdue University.

C. F. J. GALLOWAY, M.E., of the British Columbia Department of Mines, is investigating the mineral-bearing areas along the route of the Grand Trunk Pacific Railway, working east from Hazelton.

A. B. GARROW, for several years in the main drainage department, City of Toronto, and now in the employ of the Toronto Harbor Commission, is in charge of the redesigning of the sewer outlets along the city's water front, found necessary in connection with the harbor development scheme of Toronto.

ARCH. CURRIE, City Engineer of Ottawa, has returned from Atlantic City, where he has been recovering from a lengthy period of illness. Mr. Currie is still unable to assume complete charge of his duties, owing to the condition of his health, and will, therefore, act merely in an advisory capacity on the more important matters until his health has been regained.

G. A. McCARTHY has been appointed to succeed C. W. Power (see *The Canadian Engineer*, June 11, 1914, p. 875), as railway and bridge engineer for the City of Toronto, and will assume his duties on July 1. Mr. McCarthy, a graduate of McGill University, Montreal, has had extensive experience in railway work, having been with the International Railway for seven years, followed by a position with the Algoma Central as assistant chief engineer, and from 1905 to 1909 with the Temiskaming and Northern Ontario Railway as chief engineer. Since then he has been with the firm of Smith, Kerry and Chase, which, after the decease of Mr. Cecil B. Smith, became Kerry and Chace, Limited. In addition, Mr. McCarthy has had sound experience on general engineering work, and will be a valuable asset to the works department of Toronto.

OBITUARY.

Notification has been received of the deaths of Robt. and E. S. Morrison in the Fraser river, B.C., at a point about 140 miles north of Kamloops. The latter was resident engineer of construction for the Canadian Northern Railway at Blue river. His brother was also engaged in railway work for the same company as timekeeper.

The death occurred in England of Prof. Robert Crawford, prominent in engineering both there and in Canada, and for a time professor of engineering at McGill University.

Early last week death came with unusual suddenness to Mr. Robt. H. Skelton, who for 6 years has been manager of the Ontario Sewer Pipe Company, Limited, Mimico, Ont. Mr. Skelton was in his 54th year.

The death occurred last week of Mr. William Armstrong, of Toronto, who was connected with early railroad work on the Grand Trunk and old Northern Railways. Prior to coming to Canada in [illegible] he was on the staff of the Midland and other railways in Great Britain.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.

The 6th semi-annual meeting of the American Institute of Chemical Engineers is being held this week at Troy, N.Y., June 17th to 20th inclusive. Technical sessions are being held at which the following papers are being read according to the programme:—

"The Application of Physical Chemistry to Industrial Processes." By W. F. Rittman.

"Studies on Filtration." By J. W. Bain and A. E. Wigle.

"Scrubber for Vacuum Apparatus for Laboratories." By Chas. Baskerville.

On Wednesday night, Professor M. C. Whitaker will present his presidential address. This will be followed by an illustrated lecture by Dr. Wm. P. Mason on the Saratoga septic tanks.

On Friday morning the following papers will be presented:—

"Shoddy and Carbonized Waste." By L. J. Matos.

"The Present Patent Situation." By M. Toch.

"Bleaching Cotton Fibre." By J. C. Hebden.

"Ozone in Ventilation." By J. C. Olsen and Wm. H. Ulrich.

The programme for the Friday night session comprises the following two papers:—

"Development of Rotary Furnaces." By R. K. Meade.

"A Combination Water Softener and Storage Tank." By L. M. Booth.

Professor M. C. Whitaker is president and Dr. John C. Olsen, Polytechnic Institute, Brooklyn, N.Y., is the secretary of the Institute.

CANADIAN MANUFACTURERS' ASSOCIATION.

The Canadian Manufacturers' Association held its annual meeting in Montreal, June 9th, 10th and 11th.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

AMERICAN PEAT SOCIETY.—Eight Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chausse, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21913—May 29—Directing that C.P.R. install gates at crossing of Hurontario St. in Tp. Toronto, to be operated by day and night watchmen; and file detail plans of said gates for approval of Engineer of Board within 30 days from date of this Order, 20 per cent. of cost of installing gates be paid out of "The Ry. Grade-Crossing Fund," and remainder by Ry. Company, 20 per cent. of cost of maintaining said gates be borne and paid by County of Peel, including wages of gatemen; remainder paid by Ry. Co. Gates be erected and in operation by July 1st, 1914.

21914—June 1—Directing that crossing of C.P.R. by St. John Ry. on Main St., city of St. John, N.B., be protected by half interlocking plant; derails be placed on St. John Ry. and home signals on C.P.R.; derails to be interlocked with said signals. Normal position of signals be at "proceed" for C.P.R. and "stop" for St. John Ry. Co.; in movement of trains C.P.R. to have priority. St. John Ry. Co. to bear and pay cost of installing, maintaining and operating half-interlocking plant.

21915—June 11—Authorizing C.P.R. to open for traffic second main line track between Agincourt, mileage 87.3, and Leaside Jct., mileage 95.6, Toronto Subdivision, Ontario Div., Ontario.

21916—June 1—Authorizing C.L.O. and W. Ry. (C.P.R.) to carry traffic over railway from Glen Tay to Agincourt, mileage 0 to 182.6, Ontario.

21917—June 1—Approving location Montreal and Southern Cos. Ry., from westerly boundary village of Granby, thence easterly upon and along Main Street, Drummond St., Irwin St. and St. Charles St., said village of Granby, subject to terms and conditions contained in said By-Law No. 192.

21918—June 1—Authorizing Nelson and Fort Sheppard Ry. Co., to construct spur into premises of The Benton Pole and Timber Co., five miles west of Erie, Lot 1237, West Kootenay Dist., B.C.

21919—June 1—Approving location Montreal and Southern Cos. Ry., from boundary line between parish St. Cesaire and parish St. Paul de Abbotsford, Co. Rouville, Que., to west boundary of town of Granby, mileage 35.05 to 45.61.

21920—June 1—Authorizing Montreal and Southern Cos. Ry., to construct across public highways between Lots 178 and 179, and between Lots 217 and 48-47, parish St. Paul de Abbotsford, Co. Rouville, Que.

21921—May 22—Directing that Dominion Atlantic Ry. fill in approaches to crossing of Grafton Road, Grafton, N.S., a distance of 300 ft. to south and 400 ft. to north; work be done at expense of Ry. Co. and maintained for period of 1 year from date of this Order.

21922—June 6—Directing that C.P.R. re-establish and maintain train service between Winnipeg and Gimli that existed prior to 1st June, 1914, until sittings of Board at Winnipeg, on Friday, June 26th, 1914, when those interested in matter shall be heard.

21923—May 29—Directing G.T.R. to construct extension of interchange track (between G.T.R. and Hamilton Radial Electric Ry. near Burlington, Ont.), so as to accommodate at least ten cars; work be completed within 60 days from date of this Order. Cost of work be borne and paid ½ by G.T.R. and ½ by Hamilton Radial Electric Ry. Co.

21924—May 28—Dismissing application Board of Trade of Sheho, Sask., for Order directing C.P.R. to remove station at that point from present location to town side of track.

21925—May 26—Dismissing application town of Gladstone, Man., for Order directing C.N.R. and C.P.R. to construct highway over respective lines of said railway Cos., at Dufferin St., in town of Gladstone.

21926—May 26—Refusing request of residents of village of Lac du Bonnet, Man., for Order requiring C.P.R. to build platform at point opposite village, and requiring local train of said Co. to stop at said platform at night and in morning.

21927—June 2—Certifying that correction of C.L.O. and W. Ry. (C.P.R.), plan to show division line between lands of W. A. Beare and Mrs. S. Beare on location indicated in red instead of on location indicated in green on plan dated May 15th, 1914, has been allowed.

21928—June 4—Authorizing C.P.R. to construct, at grade, its Lake Louise Branch Line across highways between mileage 0 and 3.55 of said Branch Line.

21929—June 4—Authorizing C.P.R. to operate its trains over bridge No. 30.5, Temiskaming Subdivision, Lake Superior Division.

21930—June 4—Amending Order No. 21706, dated April 21st, 1914, by striking out word "clearance," in two last lines of operative part of Order, and substituting word "distance."

21931—May 29—Directing that C.P.R. construct subway at crossing of Hurontario St., Tp. Toronto, Co. Peel, Ont.; subway to be 20 ft. wide and have 14 ft. clearance. Work be completed by September 1st, 1914. 20 per cent. cost of construction be paid out of "Ry. Grade-Crossing Fund," remainder as follows:—15 per cent. by Tp. Toronto, and 85 per cent. by Railway Company.

21932—June 1—Authorizing Bay of Quinte Ry. Co., to open for traffic diversion of its line in Lots 32, 33 and 34, Con. 8, Tp. Camden, Cos. Lennox and Addington, Ontario.

21933—June 4—Authorizing V.V. and E. Ry. and Nav. Co., to reconstruct bridges across C.P.R. at Grand Forks, B.C., subject to condition that should any additional tracks be built by C.P.R. at said point, V.V and E. Ry. and N. Co. bear and pay expense of making necessary changes to provide for same.

21934—June 2—Authorizing G.T.R. to construct siding into premises of Siemon Brothers, Limited, Park, Lot 1 and Park Lot 0, town of Wiarton, Ontario.

21935—May 26—Dismissing application Frank Yestran, village of Rosewood, Man., for Order requiring C.N.R. to stop its "Flyer" train at Dufresne, Man.

21936—June 5—Amending Order No. 21913, dated May 29th, 1914, by striking out word "Hurontario," where it occurs in recital and operative parts of Order, and substituting word "Dundas."

21937—May 29—Directing that G.T.P. Ry., file with Board, within 30 days from this date, plans showing location of Standard No. 1A Station with 60 ft. platform at point between Tofield and Deville, Mile Post 759, stock pen with necessary platform and loading chute, also spur to hold at least 4 freight cars; all to be completed before Sept. 1st, 1914. Also that wayfreight and passenger trains, other than through passenger trains, stop at said station.

21938—May 29—Authorizing city of Edmonton, Alta., to open Spruce Ave., across C.N.R. in Edmonton; and it is also authorized to construct its Municipal St. Ry. across C.N.R., at rail level, on Spruce Avenue, subject to and upon certain conditions. Pending installation of half-interlocking plant. City is authorized to operate cars over C.N.R. subject to condition that crossing be protected by watchmen to be appointed by C.N.R.; wages of watchmen to be borne and paid by city of Edmonton.

21939—May 29—Directing that C.N.R. widen loading platform at Vegreville, Alta., to 20 ft. within one month from date of this Order.

21940—May 28—Directing that C.N.R. construct and complete on or before July 1st, 1914, a one-pen stock yard and loading chute at Wiseton, Sask.

21941—May 29—Directing that C.N.R. file plan showing location of a fourth class station at village of Hughton, Sask., station to be erected and station agent appointed on or before July 15th, 1914.

21942—June 5—Authorizing Montreal and Southern Cos. Ry. to construct across parish line between parish of St. Paul de Abbotsford and parish of Granby, and public high-

ways known as Frith Road, between Lots 834 and 835, Cannan Road, between Lots [illegible] and [illegible], and Robinson Road, parish of Granby, Co. Shefford, Que.

2194[illegible]—June 5—Authorizing Essex Terminal Ry. Co. to open for traffic its railway from connection with C.P.R. to connection with M.C.RR. and Detroit Tunnel Company, town of Sandwich, Ont.

21944—June 5—Authorizing Lake Erie and Northern Ry. to construct reinforced retaining walls along Jubilee Terrace and Water St., city of Brantford, Ont., and span over its tracks for extension of Lorne Bridge.

21945—June 4—Granting leave to Okanagan Telephone Company to place its wires across Shuswap and Okanagan Ry. Co. at Okanagan St., city of Armstrong, and at Gore St., city of Vernon, B.C.

21946—June 2—Approving agreement, dated May 5th, 1914, entered into between Bell Telephone Co. and Bobcaygeon Rural Telephone Co., Limited.

21947—June 4—Extending collection and delivery limits of Dominion Express Co. in town of Banff, Alta.; and rescinding the Order No. 18740, dated February 20th, 1913.

21948—June 4—Authorizing G.T.P. Ry. to construct main line across Government Road, B.C., at mileages 241 and 245, Lots 2,400 and 7867, Yellowhead Pass West, Cariboo Dist, B.C.

21949—June 4—Approving temporary diversion C.P.R. Main Line at mileage 39.3, Sudbury Subdivision, Lake Superior Div., and construct at grade, for period of 5 months from date of this Order; temporary diversion across North Road, Parry Sound, to Byng Inlet.

21950—June 2—Authorizing C.P.R. to construct, by means of grade crossings, Weyburn-Stirling Branch Line across fifteen (15) highways, between mileages 253.35 and 277.78.

21951—June 5—Authorizing C.L.I. and W. Ry. (C.P.R.) to construct, at grade, in town of Bowmanville, two (2) tracks across Scugog St., to proposed freight yard in Subdivision, Lots 145, 178, 179, 184 and 185, Block 1, said town; all switching movements across Scugog St., on said spur, be flagged.

21952—June 5—Authorizing C.P.R. (1) to revise grade of main line, Thompson Subdivision, crossing Lorne St.; (2) construct, by bridge, additional track (double track) of main line across Lorne St., Kamloops, B.C.; (3) to make revision of location of portion from mileage 0.22 to 0.55.

21953—June 5—Approving and authorizing clearances at spur for Crown Feed and Produce Co., at Calgary, Alta., subject to Company undertaking to keep employees off tops and sides of cars when operated over said spur.

21954—June 5—Authorizing C.L.O. and W. Ry. (C.P.R.) to construct, by means of grade crossings, its business spur across C.N.O.R. main line and spur at mileage 1.05 and 0.55 of spur, subject to and upon certain conditions; and rescinding Order No. 21481, dated March 13th, 1914, and Order No. 21740, dated May 4th, 1914.

21955—June 5—Authorizing city of Hamilton, Ont., at own expense, to construct and maintain Burlington St., or Base Line, being original road allowance for road between Lot 7, B.F. Con. and Con. 1, Tp. Barton, Co. Wentworth, now city of Hamilton, across portion of road allowance claimed by Hamilton Radial Electric Ry., as forming part of right-of-way.

21956—May 22—Directing G.T.R. to construct spur into premises of Hepworth Silica Pressed Brick Co., Limited, Hepworth, Ont., subject to certain conditions.

21957—June 8—Authorizing G.T.P. Ry. to construct bridge across Phillips Creek, mileage 102.2 Prince Rupert East, B.C.

21958—June 8—Directing that joint rate on coke, in carloads of a minimum weight of 40,000 lbs. per car, from Consumers' Gas Co.'s siding on Esplanade, Toronto, to sidings of C.P.R. at North Toronto, be reduced from 95 cts. to 60 cts. per ton of 2,000 lbs., effective not later than June 22nd, 1914.

21959—June 9—Directing that C.P.R. construct, at expense of Damase Goyotte of Lemoyne, Que., farm crossing [illegible] east of west switch of passing siding, parish St. Athanase, Co. Iberville, Que.; work be completed within 30 days from date of this Order.

21960—June 9—Approving location G.T.P. Branch Lines Co. station at Avonhurst, Sask., Sec. 26-19-16, W. 2 M., Melville-Regina Branch.

21961—June 9—Authorizing G.T.P. Ry. to construct bridge across Ksi-Den Creek, mileage 147.3, Prince Rupert East, B.C.

21962—June 8—Authorizing G.T.P. Ry. to construct bridges across Fiddler Creek, mileage 127; Porcupine Creek, mileage 133.5; Lorne Creek, mileage 129; and Kitwanger Creek, mileage 152, Prince Rupert East, B.C.

21963—June 8—Extending, until November 4th, 1914, time within which G.T.R. complete spur into premises of Dominion Stove and Foundry Co., Limited, town of Penetanguishene, Ontario.

21964—June 8—Authorizing C.N.O.R. to construct spur to ballast pit across public road between Cons. 1 and 2, Tp. Pembroke, Co. Renfrew, Ontario, and operate same for 3 years.

21965—June 9—Approving location C.N.O.R. station at Ste. Dorothee (Isle Jesus), Co. Laval, Que., mileage 39, Hawkesbury East.

21966—June 6—Authorizing Edmonton, Dunvegan and B.C. Ry., to construct across thirteen highways in Province of Alberta.

21967—June 9—Relieving M.C.R.R., and Pere Marquette R.R. from erecting and maintaining fences on boundary line between respective rights of way on south side M.C.R.R. and north side of P.M.R.R.) at points west of St. Thomas, Ontario.

21968—June 9—Ordering the Dominion Express Co. to publish and file special tariff applicable to through shipments of milk or cream to Boston, Mass., establishing certain rates.

21969—June 11—Dismissing applications of Sheldons, Limited, Galt, Ont., and the Sirocco Co., of Windsor, Ont., for an Order reducing the carload rating of heating and ventilating apparatus in the Can. Freight Classification from 5th to 6th class.

21970—June 5—Authorizing the Lake Erie and Northern Ry. Co. to construct its railway across the highway between Cons. 8 and 9, Station 914-61.7, at mileage 37.36, Tp. of Townsend, by means of a subway.

21971—June 9—Authorizing the C.L.O. and W. Ry. to construct, maintain, and operate a business spur from a point on its main line in Trenton, Ont., at mileage 87.46 from Glen Tay, equal to mileage 0.00 of the proposed spur, to a point in Lot 1, on the northwest corner of Ontario and Dundas Sts., in said town, at mileage 0.00 and station 42-85.7 which is equal to Station 26-23.2 of the spur as originally located.

21972—June 8—Authorizing the C.P.R. to construct, maintain and operate branch line of railway, or spur, for the Canmore Coal Co., Canmore, Alta., from a point on existing spur in the S.E. ¼ of Sec. 29, Tp. 24, R. 10, west 4th Mer., on C.P.R. main line at Canmore, Alta.

21973—June 9—Approving revised location of a portion of the C.P.R. Co.'s Swift Current North Westerly Branch line from a point in Sec. 2, Tp. 23, Rge. 27, west 3rd Mer., at mileage 94.64, to a point in Sec. 3, Tp. 23, R. 27, W. 3 M., at mileage 97.29, and from a point in Sec. 3, Tp. 23, R. 29, w. 3rd Mer., at mileage 109.10, to a point in Sec. 17, Tp. 23, R. 29, W. 3 M., at mileage 111.95 of Swift Current North Westerly Branch Line.

21974—June 8—Further extending the time within which the C.P.R. complete the sidings for the Godson Contracting Co., Tp. Darlington, Co. Durham, Ont., until September [illegible]th, 1914.

21975—June 9—Ordering the C.P.R. to divert crossing into the highway of the public road just west of Armilla, Sask., about eight hundred ft. east therefrom.

21976—June 1[illegible]—Ordering the G.T.R. to switch cars, when desired by the municipality, to and from the track on the Esplanade owned by the town of Cobourg.

2197[illegible]—May [illegible]—Amending Order No. [illegible], October [illegible]th, 1913, by substituting the plan marked "A," dated November [illegible], 1913, for the plan dated July [illegible]th, 1913, approved under the said Order.

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The Canadian Engineer

A weekly paper for engineers and engineering-contractors

PROVENCHER BRIDGE, ST. BONIFACE, MAN.

GENERAL DESCRIPTION OF DOUBLE-LEAF BASCULE BRIDGE TO BE ERECTED OVER THE RED RIVER BETWEEN ST. BONIFACE AND WINNIPEG.

TENDERS have been called for the supply and erection of the superstructure for a bridge to cross the Red River between Provencher Avenue, St. Boniface, and Water Street, Winnipeg. The superstructure is to be a double-leaf, Strauss trunnion, bascule bridge, spanning a 105-foot channel on a 60° skew. The bascule span is to consist of two through girder-spans, the main trunnions of which are supported on two trunnion posts for each girder. The construction further includes two towers, in addition to reinforced concrete counter weights, supported from the tail ends of the girders and maintained in a horizontal position during the operation of the bridge by means of structural steel counter weight lengths.

The live load uplift is taken by supports in the front and by supports in the rear connected to the approach spans.

The machinery for the operation of the bridge embraces trains of gears operated by electric motors and actuating operating pinions, one for each girder, engaging segmental cast iron racks bolted to the tail ends of the girders. The motive power is to consist of 4 electric motors for general operation of the bridge and additional motor for the operation of the centre locks. They are to be series wound and of the enclosed railway type. Each motor is to be furnished with a brake held in the set position by a spring strong enough to overcome about 135 per cent. normal motor torque and to be released by enclosed solenoids and held automatically in release. The equipment is also provided with a hand-brake. The control of the leaf motors and of the centre lock motor will be quickly interlocked with each other in such a way that it will be impossible for the operators to start the leaf operating motors until the locks have actually been released; also in closing it will be impossible for the operator to close the locks until the bridge has been completely closed. This interlocking is accomplished, not by mechanically locking levers, but by preventing the operator to get current into his motors until the preceding motion has actually been performed. An automatic cut-off will throw the circuit-brakers out on the operating motor circuits and set their brakes when the bridge reaches nearly its open or its closed positions. The electrical equipment is so designed that each leaf can be operated from its adjacent operator's house. The centre lock mechanism is to be operated from one of these also.

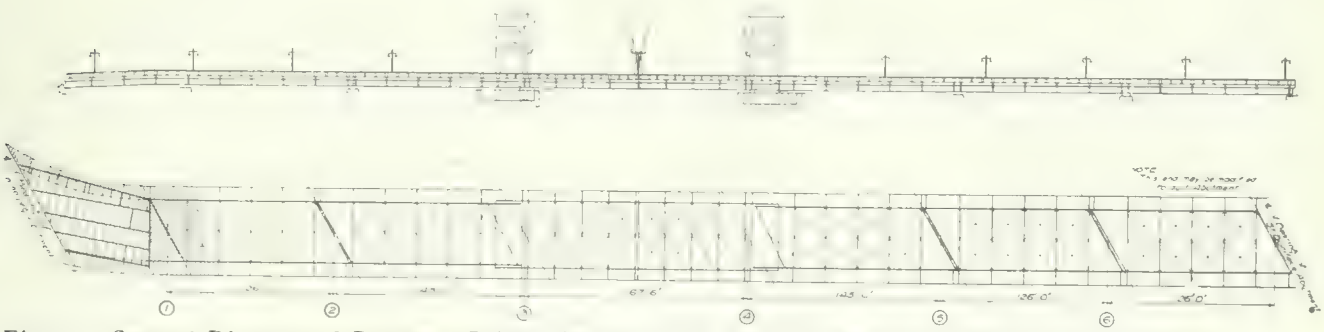


Fig. 1.—General Diagram of Proposed Bridge Over the Red River, Between Winnipeg and St. Boniface.

Reinforced concrete counter weights will be used, and, as stated, will be connected to the tail ends of the bascule girders. Each will be in the form of a monolithic concrete block, with recesses for additional material for adjustment, and will be supported on a structural steel frame. The concrete mix will be 1 of Portland cement: 8 of sand and crushed stone, and will weigh about 148 lbs. per cubic foot. Altogether there will be about 2,338 cu. yds. of concrete, including reinforcement in the counter weights.

The bridge floor will have a clear width of roadway of 44 ft. between the main girders. Two sidewalks, each 19 ft. in width, will be carried on steel brackets outside of the main girders. The bridge will be provided with two lines of car tracks, spaced 11 ft. 9 in. from centre to centre of the tracks, and it will provide head room to suit the trolley wires being placed 18 ft. from the top of the rails. The dead load will thus consist of the weight of the steel in the girders, floor system, hand-rails, laterals, etc., the weight of concrete in sidewalks and floor and the weight of pavement, rails, etc. The

...ain girders are proportioned to carry the following loads:—

Portion of span in ft.	Lbs. per cu. ft. in each car track.	Lbs. per sq. ft. of remaining floor, including walks.
100	1,800	100
110	1,740	98
120	1,680	96
130	1,620	94

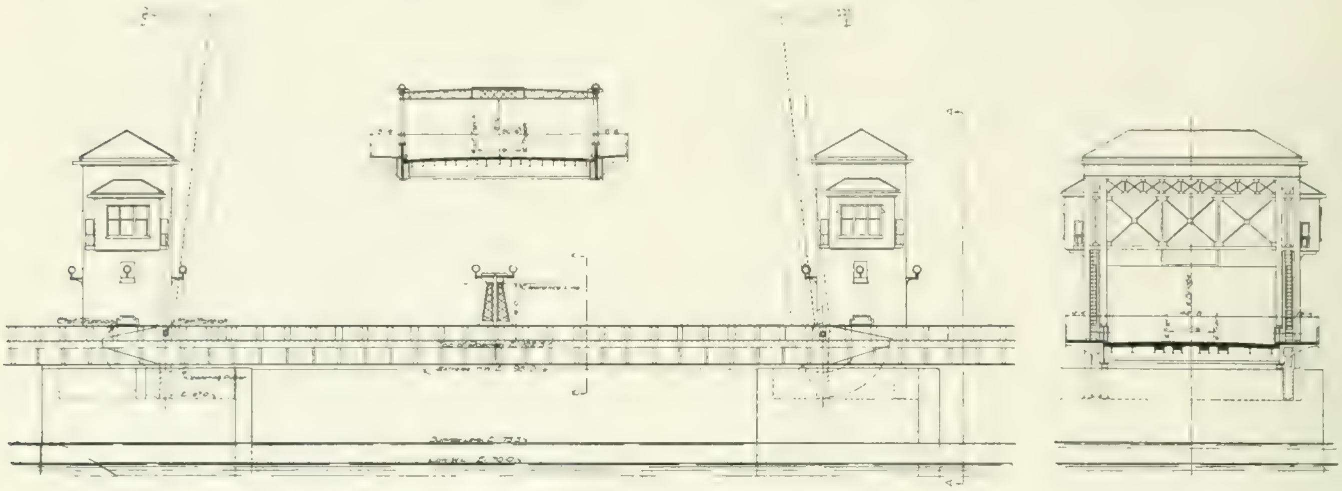


Fig. 2.—Elevation and Sections of the Bascule Section of the Provencher Bridge.

The floor beams are designed for a concentrated load of 30 tons on two axles, 14 ft. apart, for each car track, assumed to occupy the width of 11 ft. and 100 lbs. per sq. ft. remaining floor surface. Stringers are designed for a concentrated live load of 15 tons on two axles, 14 ft. centres and 16 tons, 10 ft. centres. A uniform load of 100 lbs. per sq. ft. is the basis of the sidewalk stringer and bracket design, while the floor slab on roadway is proportioned to support a concentrated load of 3 tons per foot in width of the slab.

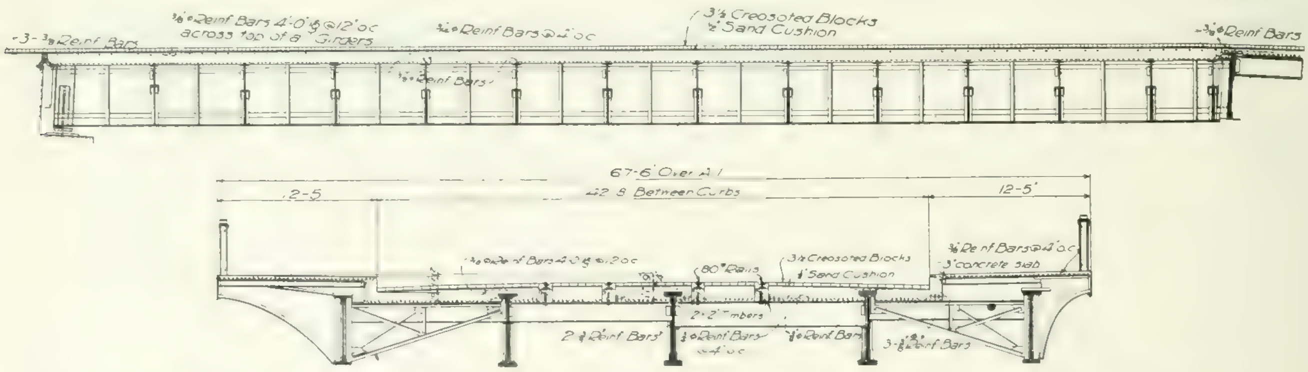


Fig. 3.—Longitudinal and Cross-sections of Span Between Abutment on the Winnipeg Side and Pier I.

Specifications consider the reinforced concrete floor and floor beams to have a sufficient bracing for wind load. A temperature variation of 150° F. is provided for, and the traction load is estimated at 20 per cent. of the greatest live load on any part of the structure. The impact load is taken as a percentage of the live load, equal to $\frac{10,000}{L + 150}$ where L is the length and feet of portion of span covered by the live load when the member considered receives its maximum stress.

The floor of the bridge will be of reinforced concrete, 6 in. in thickness, and supported on steel stringers, the reinforcement to consist of plain, round rods placed at right angles to the centre line of the bridge. The floor mix will be 1:2:4. The surface will be crowned 3 in. from sides to centre. The specifications call for a cement and sand cushion ½ in. thick with a 3½ in. creosoted wood block pavement or an alternative No. 1, sheet asphalt on the fixed spans, this to have a 2-in. surface on a 1½ in. binder.

It has recently been announced that alternative tenders will be considered on other designs for this bridge to comply with the specifications. If trusses are used in them instead of plate girders it is necessary, however, that they be not over 14 ft. in height.

The work is to be completed by Nov. 1st, 1915. The bridge itself is designed by the Strauss Bascule Bridge Co., of Chicago. Col. H. N. Ruttan is consulting engineer of the work. M. P. Blair, city engineer of St. Boniface, will supervise its erection.

SEVENTH CONGRESS OF THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

The Seventh Congress of the International Association for Testing Materials will be held under the patronage of H.M. the Czar of Russia, in St. Petersburg, from August 12th to 17th, 1915. Four days will be devoted to the discussion of the most important problems on testing materials. After the Congress extensive excursions in the interior of Russia have been arranged.

The president of the Association is N. Belelubsky, St. Petersburg; vice-presidents, A. Martens, Berlin; A. Mesnager, Paris; G. C. Lloyd, London; R. W. Hunt, Chicago, and general secretary, E. Reitler, Vienna.

TYPES OF FLOORS FOR LIGHT HIGHWAY BRIDGES.

IN the latest annual report of the Illinois State Highway Commission the question of floors for steel highway bridges is reported upon. The suggestions given concerning them are given below:

The largest item of expense in connection with the upkeep of steel bridges not having concrete or other permanent floors, is that of floor maintenance. Until a few years ago, the floor almost universally specified for country highway bridges consisted of white or burr oak plank, from 2½ to 3 inches in thickness. When first-class material could be obtained at a cost of $25 per thousand feet board measure, such floors proved to be fairly economical if not subjected to heavy traffic. But now it is almost impossible to obtain at any price a good quality of white or burr oak bridge plank.

The lightest concrete floor that can be designed to carry modern traffic with safety weighs 40 pounds or more per square foot, and in order to protect such a floor from excessive wear and to distribute concentrated loads sufficiently so that they will not produce local failure, a wearing surface of gravel, macadam or brick weighing a minimum of 50 pounds per square foot is necessary.

Steel bridges carrying plank floors are rarely, if ever, designed to carry more than the dead weight of the bridge itself, which includes about 12 pounds per square foot for the floor, and a live load of 100 pounds per square foot, provided by law.

To place a concrete floor on a steel bridge, designed to carry a plank floor, would impose, therefore, an additional dead load on the structure amounting to the difference between 90 pounds per square foot, the weight of the concrete floor and wearing surface, and 12 pounds per square foot, the weight of a plank floor, or about 78 pounds per square foot.

The proposed floor must weigh but little more than the floor for which the structure was designed; it must not be unduly expensive, and it must be as durable as possible.

The material which best meets these requirements seems to be timber treated with creosote oil to prevent decay. All woods treated with creosote oil seem to resist decay equally well. Any wood may, therefore, be used which is susceptible to the creosote treatment and which will resist the wear coming upon it.

For existing wood floor steel bridges, located in or near cities, which carry a considerable amount of traffic, it is recommended that a creosote wood block pavement be laid on creosoted pine sub-plank. Such a floor weighs about 30 pounds per square foot. This is about 18 pounds per square foot in excess of the floor weight a majority of wood floor steel bridges are designed to carry. However, as this type of floor is very much smoother and stiffer than the ordinary plank floor, the reduction of vibration due to heavy moving loads is greatly decreased. This is a factor of safety which will balance somewhat the greater dead weight of the structure. However, a careful investigation of the strength of the bridge should be made before a floor of this character is laid.

At present prices for material this type of floor can be laid for about four times the cost of a 3-inch plank floor. If proper materials and workmanship are used, there is little question but that such a floor will last 12 years or more, possibly 25 or 30 years.

For existing bridges in good condition and of proper design, located on roads at some distance from a city, carrying a moderate amount of traffic, a floor consisting of 3-inch creosoted sub-plank on which is placed a wearing surface about three-quarters of an inch thick of fine gravel or stone chips flushed with heavy asphaltic filler will be found serviceable and economical. Such a floor, if properly constructed, will present a smooth, elastic surface which will reduce vibration. A floor of this character weighs but a few pounds per square foot more than a 3-inch oak plank floor and is far more durable. The wearing surface will probably require renewal at intervals of from 2 to 6 years, depending upon traffic conditions. As the wearing surface may readily be renewed by day labor, at a cost of about 50 cents per square yard, the item of maintenance is small compared with the cost of maintaining an untreated plank floor. There is no reason why a floor of this character should not last as long as a creosoted block floor, providing the sub-plank is kept protected from wear by a properly maintained wearing surface.

For existing country highway bridges, in good repair and of sufficient strength, where traffic is light and little wear comes upon the floor, creosoted oak plank with no special wearing surface can often be used. Red oak can be used to advantage for this purpose, as it is readily susceptible to treatment with creosote oil, wears less than a softer wood and will probably last as long, as far as decay is concerned, as any other creosoted timber.

In this connection it is worthy to note that the rate of wear on an ordinary plank floor greatly increases with the age of the plank, owing to the softening of the wood as decay advances. As the creosote treatment protects the plank from decay, a floor of this character will wear better than a floor of untreated material, as the wood remains hard and resistant until decay sets in.

In the light of the above discussion it is, therefore, well to hold in mind the following points:

1. Old steel bridges are rarely, if ever, strong enough to carry with safety a concrete floor.

2. For existing steel bridges in good condition and of satisfactory design, located in cities or elsewhere where traffic is heavy and ordinary plank floors rapidly wear out, it will be found economical to refloor with creosoted sub-plank and creosoted blocks.

3. For existing steel bridges in good repair and of satisfactory design, carrying moderate traffic, but yet where wear is of considerable importance, it will be found economical to use creosoted plank with a bituminous wearing surface.

4. For existing steel bridges in locations where an ordinary plank floor rots rather than wears out, a creosoted plank floor with no special wearing surface will be found economical.

If a proper selection of floor is made, and the material used is subjected to rigid specifications and inspection, this floor should in most cases outlast the steel bridge on which it is placed.

A proposal is on foot to build a bridge across the harbor of North Sydney, Australia, in conjunction with a new underground railway system. This bridge will be the third largest in the world as regards length of span, and the first as regards headway for shipping. The specification provides that it shall consist of nickel-steel cantilevers supporting centre girders, also of nickel steel. The shore arms of the cantilevers will be some 500 ft. long, and the cantilever arms 520 ft. long, the length of the centre girder being 560 ft. The approaches to the bridge will consist of steel arch spans of the three-hinged spandrel braced type.

THE METHODS AND WORK OF THE EMSCHER-GENOSSENSCHAFT.

By Prof. P. Gillespie, C.E., University of Toronto.

THE Emscher River is a tributary of the Rhine, the confluence being 12 miles below Essen, famous as the headquarters of the Krupp steel industries. The stream has an average discharge at its mouth of 300 cubic feet per second, a volume equivalent to one-seventh of that of the Canadian Trent at low water. It drains an area of 300 square miles which supports a population upwards of 2,000,000 people; so that the number of persons to the square mile is over 6,600. If the entire population of Canada were placed on the province of Prince Edward Island, the congestion would be less than half that obtaining in the Emscher valley. Predominatingly industrial is the district owing to the prevalence of coal deposits and mines and the stimulus which these give to the manufacture of iron, steel and steel products. The larger centres are Oberhausen, Essen, Gelsenkirchen, Bochum, Recklinghausen and Dortmund. The seriousness and complexity of the problems involved in the satisfactory drainage of such a district will readily be appreciated, but here, as elsewhere, the situation seems to have developed both the men and the method.

In 1906 an act of parliament passed by the Prussian government created the so-called Emschergenossenschaft or Emscher Federation and conferred upon it wide powers and much authority. On this board are represented the government, the municipalities, the mines, the industries and the farmers. Its work comprises the regulation of the Emscher River and its tributaries and the design and construction of bridges, sewers and sewage disposal works. It has authority to levy rates for these undertakings and to that end, to make assessments in which the responsibility for nuisance and the benefit to be derived from its amelioration are the determining factors in the award. Dr. Karl Imhoff is the chief engineer of the sewage division of the federation's work, and it was under his direction that the work of perfecting that type of clarification tank which bears his name and which has come to be regarded as the feature of the Emscher method of sewage treatment, was carried out. The Emscher Federation is a splendid example of effective organization and efficient management and is successfully executing a work which could not have been carried out by independent effort except at enormous waste of energy and money. It has expert service to apply to the solution of each individual problem; it eliminates the too-often costly experimenting of the novice; it secures economy; avoids unnecessary duplication, and is a happy compromise between public and private control. So pronounced are its advantages that one often wonders whether some of its methods and organization could not with great advantage be copied in this country. If our Provincial government with much acceptance can supply our municipalities with electrical energy, why can it not at least design our sewage disposal works? The latter undoubtedly touch the well-being of the community in at least as vital a way as the former.

The Emscher River is not generally a source of public water supply. In consequence the necessity for carrying the purification of sewage to the limit of excellence there, does not exist. In all cases, except in the upper reaches of the valley, the sedimentation of the sewage in Imhoff tanks combined with the subsequent treatment of the sludge constitutes practically the whole process. This makes for economy and simplicity of method and represents the general practice of the Board.

The first of the large Emscher plants was constructed at Recklinghausen in 1907. The Emscher year-book for the fiscal year ending March 31, 1913, states that at the time of its publication there were 19 separate plants within the jurisdiction of the Emschergenossenschaft comprising 123 Emscher tanks and serving in the aggregate 870,000 people. During the year then closing four urban communities, aggregating in population 210,000, had been supplied with clarification plants. This involved the construction of 34 Imhoff tanks exclusive of the doubling of the capacity of the old plant at Essen-Nordwest, also completed during the year. Mr. Leslie Frank, now with the Baltimore Sewerage Commission, who spent last year as a member of Dr. Imhoff's staff in Essen, states that in the German Empire there are probably 100 plants using the system. It has thus been tried out for seven years on a scale of great magnitude in Germany and so successful has it proved that a federation similar in its organization to the Emschergenossenschaft has recently been formed for the watershed of the Rhur, adjacent to the Emscher valley. This stream is another tributary of the Rhine with a flow ten times that of the Emscher and a drainage area six times as large. Of this, Dr. Imhoff is the chief engineer. Construction was begun there a year ago.

A visit to the works under Dr. Imhoff's care confirms all that has been said from time to time regarding the results which are attained there. The Imhoff tank is primarily a device for the inoffensive treatment of sludge and it is to that device that the visitor's attention is naturally directed. An attendant opens one of the sludge valves allowing the liquid sludge to escape. In color it is always black. Although its water content is less than that of fresh sludge by 20%, it is more mobile than the latter and flows freely. Its odor is that of hot asphalt or scorched rubber. So distinctive is this, that by the smell, properly rotted sludge may be readily identified. The smell of sour milk so characteristic of insufficiently decomposed sludge is here entirely absent. Especially noticeable is the rapidity with which the sludge separates from its water. This is one of the most important, and from the engineer's standpoint, one of the most fortunate of its characteristics. On the sludge-drying bed the sludge floats to the top and the water sinks to the bottom and drains away through the sand or cinder layers below. It is interesting to observe that while the sludge-drying area is in Germany ⅓ sq. ft. per inhabitant, in Birmingham it is 2 sq. ft.

The visitor's attention is attracted to the active and constant ebullition taking place in the gas vents to the digestion chambers. The liquor there is inky black and the escape of gas is most vigorous though not offensive to the sense of smell. It is commonly stated that this gas is roughly ¾ methane and ¼ carbonic acid gas, but the writer has not seen any analyses that could be considered the results of precise work, though doubtless such are available. Over one of the rectangular vents at the plant at Essen-Nord, a metallic hood terminating in a gas-pipe has been erected. The escaping gas, if ignited, will burn continuously. This plant, by the way, is the largest controlled by the Emscher Board, serving as it does a population approximately three-eighths that of Toronto. The sewage is a mixture of domestic and industrial since the Krupp steel works and other large industries are located there. There are eighteen Emscher tanks in all, twelve of the longitudinal flow and six of the radial

flow type. There is no offensive odor. In the immediate neighborhood are the plant of the Rhenish Westphalian Electrical Company and the dwellings of the workmen. Some of our municipal authorities will be interested in the fact that the per capita charges for interest, sinking fund, administration and maintenance are less than five cents per annum.

Some doubts have been expressed as to the likelihood of Emscher tanks working efficiently in this latitude because of the much lower temperature. These misgivings, in the view of the writer, are without much foundation. In the first place, let it be remembered, the temperature of sewage does not fluctuate markedly in response to temperature changes in the atmosphere. The reason for this is obvious, particularly where the community is sewered on the separate system. The sewers are buried in earth whose temperature is nearly constant. Furthermore, the opportunities for fluctuation of temperature in the decomposing chamber of an Emscher tank are very much less than in an ordinary sedimentation or septic tank. The decaying process in the former takes place under 25 feet of nearly stagnant water and into this digestion chamber almost no fresh sewage is permitted to enter. It is interesting to observe, moreover, that there is less than 5 deg. F. difference between the mean annual temperatures of Toronto and Essen, Germany. In the second place, it must not be forgotten that the activity of sludge decomposition depends upon many influences other than temperature, as the experiments of Guth and Spillner in 1911 have shown. In this series, observations were made on the manner in which decay of organic substances takes place in sewage tanks of various types. At thirteen different stations, all of them within a triangle determined by Hamburg, Essen and Leipzig, and representing every possible kind of sewage, parallel tests were made. The average temperatures over a period of eight weeks are reported as varying from 48 deg. F. in the sewage disposal plant at Harzburg, to 71 deg. F. in the Emscher tank in the sewage disposal plant in Essen-Nordwest. On the whole, the most complete digestion took place at a station in Hamburg, where the temperature was about 60 deg. F. Of the 13 tank temperatures, four were higher than this one. In the third place, observation shows that at the plants of two adjacent communities sewage temperatures at the same time may sometimes differ very much more than the fluctuations of either between summer and winter seasons. To minimize this latter variation in this country, it will often be advisable to provide covers.

That the dried sludge has some manurial value is evidenced by the fact that farmers are willing to take it at a small price for use on the land. At Recklinghausen it brings 12 cents per cart load; at Erfurt (not in the Emscher district) it sells at 7½ cents per cubic yard. On the sludge dumps about the Emscher plants, it is a common sight to see luxuriant vegetation. In contrast with this is the appearance of the dried sludge banks at Birmingham which support not a single blade of grass. The presence of copper and other metallic salts in considerable quantities in the sewage of the latter place is thought by some to be the explanation.

It is significant that the supposed failures of the Imhoff system are not in the Emscher valley. Indeed, some of the alleged failures elsewhere investigated by the writer, were found to be working excellently. The skilled supervision received from the operating staff of the Emschergenossenschaft assists materially in bringing to a satisfactory working state the plants under its control. Probably the lack of it elsewhere explains why satisfactory working conditions are so long deferred in a few other plants. The writer found one Imhoff tank installation in central Germany which produced a good inoffensive sludge for the first time three years after being put into operation. Needless to say, the plant was not under the supervision, directly or indirectly, of the staff of the Emschergenossenschaft.

Of the Imhoff tank, several modifications and adaptations have come into being. One of these is exploited by the holders of the Kremer patents, the Sewage Purification Company of Berlin, who have adapted their fat-arresting device to the double-story tank of the Imhoff type and who claim to have installed over 50 large purification plants for towns, communities and institutions. Another is the Städtereinigung und Ingenieurbau A. G., of Wiesbaden and Berlin, selling under the cryptographic commercial designation of "Stiag." A somewhat similar state of affairs exists on this side of the water.

In the United States some 25 cities, towns and institutions have constructed Imhoff tanks. Rochester, N.Y., one of the latest, is planning for 20 tanks to serve a population of 400,000. In Canada, a few have been or are being built. In England, outside of Dr. Travis' hydrolytic tanks at Norwich, Hampton and Luton, not one known to the writer has been or is being constructed. Dr. Fowler, of Manchester, and Mr. J. D. Watson, of Birmingham, have constructed experimental tanks of the Emscher type at the sewage disposal works of those cities. With typical conservatism, the Britisher prefers to wait until he is absolutely sure of his ground.

The writer regards the Imhoff tank as representing the most significant advance made in the art of sewage purification during the past ten years. This not because of small initial cost or ease of construction, neither of which it probably possesses, nor because in the general case it constitutes a method of sewage treatment complete in itself, for it does not, except in special cases like the Emscher valley, but because it affords an undoubted solution to that most troublesome phase of sewage treatment—the disposal of sewage. To anyone who has encountered the penetrating stench emanating from putrefying sewage as it exists at many plants, the extra cost will be justified. Moreover, the favorable representations made by visitors to the German plants regarding this odor question have not, in the opinion of the writer, been exaggerated.

What the future has for the art of sewage treatment it is impossible to say, but since, at the hands of specially trained investigators in Europe and America, the problem is receiving much attention, it cannot be believed that a finality has been reached. But even if no improvement upon existing processes were to be realized, the methods of to-day are producing results which, in the main, are satisfactory, and which are available to all our cities and towns at moderate cost.

A feature of the prospectus just issued by the Lucky Strike Oil and Gas Company, Limited, of Calgary, Alta., is the fact that the company proposes drilling for oil and petroleum gas at or near Aldersyde, close to a well that is now producing petroleum gas at a depth of only 280 feet. The company will drill a number of wells until a flow of 4,000,000 feet of gas is obtained. Bessemer condensers will be installed for the purpose of extracting the gasoline, and at the low estimate of 25 cents per gallon, it is anticipated that the revenue of the company from this source alone will amount to $1,000 daily.

CRITICAL LOADS FOR IDEAL LONG COLUMNS.*

By Arthur Morley.

(Concluded from last week.)

EXAMPLE IV.:—

As a nearer approximation to a practical shape, take a column of uniform type of section, but the linear cross-sectional dimensions varying uniformly from the fixed to the free end at which they are half those at the fixed end—e.g., a conical pillar—

$$I = I_1 \frac{(l + x)^4}{16\, l^4} \qquad . \quad . \quad . \quad (31)$$

Assuming the curve (2) the successive approximations to P are $\frac{E\, I_1}{l^2}$ multiplied by $3/2$, $15/14$, $147/142$, etc., or 1.5, 1.071, 1.035, etc., respectively.

If we assume as a starting point

$$y = y_0 \qquad . \quad . \quad . \quad (32)$$

which, as a second approximation, yields the curve taken under the action of the couple $(P\, y_0)$ at the free end of the corresponding cantilever—viz.—

$$y = y_0 \left(\frac{l^2}{2(l + x)^2} + \frac{x}{2\, l} - 1\right) \qquad . \quad (33)$$

the successive approximations for P are $\frac{E\, I_1}{l^2}$ multiplied by ¾, 30/31, 31/32, etc., or 0.75, 0.96774, 0.96875, etc. The limit is evidently approached very quickly, and it may be taken as very near to $0.97 \frac{E\, I_1}{l^2}$. In any case it has been reduced to the range between 1.035 and 0.97 times $\frac{E\, I_1}{l^2}$.

Economy of Material.—If A_1 is the cross-sectional area at the fixed end, the volume of the column in Example IV. is $\frac{7}{8} \times \frac{1}{3} A_1 \times 2\, l = \frac{7}{12} . A_1\, l$. A column of uniform cross-section and the same volume has a moment of inertia of cross-section equal to $\left(\frac{7}{12}\right)^2 \times I$, and its critical load is $\frac{\pi^2}{4\, l^2} . E \times \left(\frac{7}{12}\right)^2 I_1 = 0.84 \frac{E\, I_1}{l^2}$, or some 13 per cent. less than that of the tapered column. On the other hand, considering the more tapered column of Example III., its volume is ½ $A_1\, l$. A uniform column of equal volume would have a critical load of $\frac{\pi^2}{4\, l^2} E \times \frac{1}{4} I_1 = 0.616 \frac{E\, I_1}{l^2}$, or nearly 2½ times that of the tapered column (which is $\frac{1}{4} \frac{E\, I_1}{l^2}$).

Curve Approximations. The statement has been made that the exact shape of the curve is not important. But it has been shown in the foregoing that while the difference in end-loaded cantilever and column curves is not so great in columns of constant moment of inertia as to give a bad approximation, the case may be very different

Fig. 2.

with tapering columns. It may be worth stating the point from simple principles as follows:—

1. It is clear from the bending moment diagrams, say, A1 B and A C B, Fig. 2, which for equal values of y_0 must have equal moments about O, that the curvature will be greater for the column than for the cantilever, for the bending moments are increased in greater proportion where their values are smaller—i.e., towards the free end.

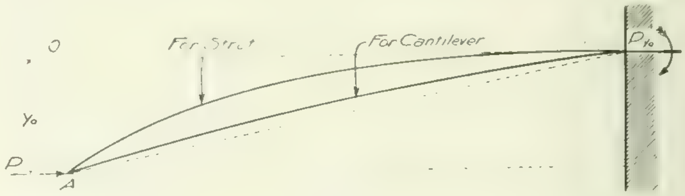


Fig. 3.

2. This is particularly the case with tapering columns, for here I decreases:—

$$\left(\frac{d^2 y}{d\, x^2} = \frac{M}{E\, I}\right).$$

3. For the displacement method—

$$y_0 = \int_0^l \frac{M\, x}{E\, I} d\, x = \frac{P}{E} \int_0^l \frac{(y_0 - y)\, x}{I} d\, x,$$

or

$$P = E\, y_0 \div \int_0^l \frac{(y_0 - y)\, x}{I} d\, x.$$

For any curve flatter than the true one

$$\int_0^l \frac{(y_0 - y)\, x}{I} d\, x$$

is underestimated, and therefore P is overestimated.

4. By the method by energy, for a curve flatter than the true one (see Fig. 3), the strain energy is underestimated, but the axial component of the movement of P is underestimated in a greater proportion; hence, from the equation P = (strain energy) ÷ (axial movement of P), P is overestimated.

Note on the Initial Choice of a Curve.—By choosing a straight line or the second approximation to which it leads—viz., the curve of an end loaded cantilever—a curve flatter than the true curve is ensured and the true critical load is approached from above. By starting from a constant deflection or the curve of a cantilever acted on by a couple at its free end to which it leads, a curve of exaggerated curvature is secured and the true critical load is approached from below. If the limit is approached

*Reproduced from April 24th issue of Engineering (London).

slowly, the use of both alternatives, when possible, may be recommended.

An alternative method of obtaining a starting point corresponding to the second approximation is to assume that the curve is of the form

$$y = y_0 \left(A + B\frac{x}{l} + C\frac{x^2}{l^2} + D\frac{x^3}{l^3}\right) \quad . \qquad (34)$$

the number of constants being equal to the number of known conditions and powers of x higher than the third vanishing when $\frac{d^4 y}{d x^4} = 0$ for all values of x. If the coefficients A, B, C, etc., are made to comply with as many of the known end conditions as possible, the resulting approximations for the curve and for the critical load will be closer than those from a curve complying with fewer of these conditions.

Thus, in Example I., for $x = 0$, $y = y_0$; therefore $A = 1$. Also $\frac{d^2 y}{d x^2} = 0$; hence $C = 0$. And for $x = l$, $y = 0$, and $\frac{d y}{d x} = 0$; hence $B = -3/2$, $D = 1/2$, from which (34) reduces to equation (7). The resulting coefficient for P—viz., 2.5—is nearer the true value, although not safer, than if we neglect the condition $\frac{d^2 y}{d x^2} = 0$, which from the general form

$$y = y_0 \left(A + B\frac{x}{l} + C\frac{x^2}{l^2}\right) \quad . \qquad (35)$$

yields the form (17) and a coefficient 2.4. Similarly, in Example III., in which $\frac{d^2 y}{d x^2}$ is not necessarily zero, the form (2), which corresponds to $A = 1$, $B = -1$, $C = 0$ in (35) gives coefficients 1, ½, 2/5, 5/14, etc., while the nearer form $A = 1$, $B = -3/2$, $C = ½$, resulting from the three conditions $y = y_0$ for $x = 0$ and $\frac{d y}{d x} = 0 = y$ for $x = l$ gives the nearer coefficients 2/3, 6/13, 26/67, 134/381, which, however, approach the same limit, but in a manner somewhat less simple to compute arithmetically.

The United States Bureau of Mines has undertaken to construct, in co-operation with the mining industry and the manufacturers of mining machinery, a mine beneath the floor of the Palace of Mines and Metallurgy at the Panama-Pacific Exposition. The financial and operative success of the mine is assured through exhibits whereby typical metal and coal mining operations will be reproduced by full size working places in which mining machinery will be installed and operated. The walls of the mine will be covered with either ore or coal typical of the mine illustrated.

The American Society of Engineers, Architects and Constructors was incorporated in New Jersey in May last, in the interests of civil engineering, architecture, engineering and building construction, and the arts allied thereto. Its board of trustees consists of Messrs. J. W. Howard, C.E., O. R. Parry, J. A. Yates, C.E., C. F. Dingman, W. P. Comstock, A.B., J. R. Draney and T. H. Boorman, C.E. At the election of officers Major S. S. Hatfield, C.E., became president and Mr. T. H. Boorman, C.E., secretary. We note among the associates of the society the names of Messrs. E. Belanger, C.E., Montreal, and D. D. Barry, Government engineer, Ottawa.

MOTOR BUS TRAFFIC—ITS DEVELOPMENT AND CHARACTERISTICS.

At the recent National Conference on City Planning, held in Toronto, Mr. John A. McCollum, assistant engineer, Board of Estimate and Apportionment, New York City, read a paper on the use of the motor bus by municipalities, and outlined many important points in connection with it in the solution of transportation problems. The following is, in part, Mr. McCollum's paper:—

The date of the first appearance of the horse-drawn omnibus in London is not definitely known, but it is certain that corporations owning and operating such vehicles were in existence as early as 1855, and during the year 1862 more than 42,000,000 passengers were carried by the 600 vehicles of one company alone. The maximum number of horse-drawn vehicles was reached in 1901. In this year 3,736 were licensed. Subsequent to that time the number gradually decreased until a few months ago, when the last horse-drawn omnibus was removed from the streets of London.

The new era began in 1901, when 10 motor buses were licensed by the police. No large increase in numbers took place, however, until 1905, when 241 vehicles were licensed. From that time down to the present, the numbers increased by leaps and bounds. There are at present in London more than 3,000 motor-driven buses, which have entirely supplanted the horse-drawn vehicles. These have a seating capacity of 34 passengers each; operate on regular schedules; move with an average speed somewhat in excess of the surface railway cars, and carry with regularity and dispatch, at a rate of fare exceeding by only 20 per cent. that of the street railways, an aggregate of 676,000,000 passengers per annum, a total greater than the number of cash fares and transfers collected on all the street surface railways of the Boroughs of Manhattan and the Bronx in the city of New York. This seems miraculous when we consider the short period within which motor-driven vehicles have been developed and adapted to this severe use.

The operating efficiency of the motor bus in London may be well illustrated by the fact that during seven continuous months of the year 1913 about 2,200 motor buses ran an average of 117 miles each per day, or an aggregate of 55,000,000 bus miles, with a loss of schedule mileage equal to only 0.12 of one per cent. of the total. This probably exceeds the efficiency of many street railway systems. In Paris there are more than 1,000 vehicles of a type unlike those in London, operating under different conditions, but performing nevertheless an efficient passenger service. New motor bus routes are being established daily in European cities.

There are two characteristics of the motor bus which distinguish it from every other public transportation facility. The first is flexibility; that is, flexibility of vehicle movement and flexibility of route. Because of this feature the vehicle responds quickly to operating requirements and to traffic conditions; e.g., passengers may enter or leave buses at the side of the roadway without risk or danger of crossing dense vehicular traffic; delays to other motor cars do not result from breakdown either of a motor bus or any other vehicle, and daily or less frequent changes of route may be made to comply with traffic conditions. All of these are advantages not to be found in any car confined to rails.

The second distinguishing characteristic is its independence of extraneous equipment, such as expensive and delicate power generating and distributing systems or

expensive track equipment. The railway investment must, in a large measure, increase in the same ratio as the length of the track, while the motor bus investment grows only in proportion to the number of vehicles employed or, what is the same thing, in proportion to the daily vehicle mileage.

The importance of this feature is shown by the comparison of the capitalization of the street railways in the Boroughs of Manhattan and the Bronx and the municipally owned and operated surface railways in London with the largest omnibus undertaking in that city. The number of passengers carried in the year 1912 by the London railway was about the same as the number carried by its omnibus system. In Manhattan and the Bronx the total number of passengers paying cash fares and presenting transfers exceeded by about 20 per cent. the number carried by the London omnibus system. The aggregate lengths of route operated were about 148 miles by London railways, about 230 miles by Manhattan and the Bronx railways and more than 300 miles by the London motor buses. Yet at the close of 1912 the London railway investment, less the accumulated sinking funds, was $53,000,000; the Manhattan and the Bronx railways' capital was $190,000,000, with an appraised property. value of $166,000,000; while the amount of capital employed by the omnibus company, as evidenced by its outstanding securities, was only $15,500,000, including an increase during the year of $5,000,000 for the purpose of supplying funds for additional facilities, the benefit of which will accrue in subsequent years.

Thus we find that the London railway investment is about 3½ times that of the omnibus. The capitalization of the street railways in Manhattan and the Bronx is more than 12 times and their appraised value is almost 9 times as great as the capital used for London omnibuses. Five per cent. profit upon the capital of the railways of Manhattan and the Bronx would equal more than 13c. for each car mile operated. The following general comparisons may be made between the operating expense of the largest existing motor bus undertakings and that of the street railways:

In London, where the operation is skillfully managed, where the pavements are kept in excellent repair and where the improvement in the type and construction of vehicle has been most rapid, we find that the bare operating cost is relatively low. It is less than 15 cents per bus mile and probably does not exceed by more than 10 to 15% the cost per car mile of the municipally owned surface railways. The excess cost is, however, more than offset by the lower interest charges on motor bus operation, and the total cost per bus mile probably is less than the cost per car mile. The relative seating capacity of vehicles used in this comparison is 34 for the motor bus and 78 for the surface car. This ratio of seating capacity brings the total cost per motor bus seat mile greater than that of the car seat mile. In Paris, where a much heavier vehicle of about the same capacity is operated on pavements less smooth, the cost per mile is considerably greater than in London.

Many conditions abroad bearing on the cost of operation differ from those in America; e.g., the comparatively low cost of labor in England, particularly, mechanical labor, of which so much is required in motor omnibus operations.

The depreciation of the motor bus is much more rapid than that of the street railway car and other railway equipment and requires provision for replacement funds at a greater rate. The total amount of depreciation may not exceed that of the railway, although the rate is higher, because the value to which the rate is applied is much less. In London the life of motor bus equipment is estimated to be from five to six years, and in New York depreciation funds are provided sufficient to replace the vehicles after three years' use. Probably the average life of motor buses constructed abroad when efficiently maintained is much longer than five years, but the mechanical improvement in type and construction has been thus far so rapid that the vehicles become obsolete before they are worn out.

Street pavement is to the motor bus what the steel railway track is to the railway car, but unlike the railway track it is provided at public expense. Its preservation, therefore, is one of the problems which will confront the authorities if large numbers of heavy motor buses are to be operated, particularly in suburban districts, where the pavements are usually less permanent than in city streets with dense vehicular traffic.

The capacity—hence to some degree the weight—of the motor bus is an extremely important consideration from the standpoint of economy, for the cost of operation per vehicle does not increase at the same rate as the number of persons which it may carry. Therefore, where the volume of traffic is sufficient, a larger vehicle is more desirable. Speed and rapid acceleration up to certain limits are also essential for passenger service. In consequence, reduction of weight per unit capacity or other improvements in design must be depended upon to keep down road repair cost rather than reduction of speed in motor bus operation.

Motor buses operated in London, Paris and New York vary in weight from 219 pounds to 365 pounds for each passenger which the vehicle is capable of carrying. The lightest vehicle is used in London and weighs about 3¾ tons unloaded. This is the maximum weight permitted by the police for a public service vehicle. It is possible to obtain American-made single-deck buses, 24-passenger seating capacity, that probably do not exceed in weight the maximum per passenger capacity authorized in London. Whether those vehicles will prove successful in the severe trials of motor bus work is yet to be proven.

There is a great need for a careful research into the whole problem of mechanical traction on roads, particularly the effect of vehicle weight and speed upon the cost of road maintenance. If it is shown that the motor bus is particularly destructive to roads, the operators should pay something toward road maintenance.

BREAKWATER CONSTRUCTION AT VICTORIA.

In connection with the construction of a breakwater in the outer harbor at Victoria, B.C., a 7,000-ton floating dry dock, owned by the Seattle Construction and Dry Dock Co. and leased to Grant, Smith & Co., will be used. Upon it concrete piers will be built, the dry dock being allowed to sink as the construction of the piers progresses. When they have been completed, they will be held in suspension by cranes while the dry dock is being removed, after which they will be properly seated in position.

There are in all 54 of these caissons to be built in connection with the contract, two of them being constructed at a time upon the dry dock. Each will have a weight of approximately 3,500 tons.

The water level is regulated by means of water-tight compartments in the bottom and sides of the dry dock.

The Dominion Government will shortly spend $200,000 in establishing an astronomical observatory near Victoria. This station will be equipped with a 72-in. reflecting telescope, said to be the largest of its kind in existence.

POINTS IN ROAD DESIGN.

At the First Canadian and International Good Roads Congress, held in Montreal in May last (see *The Canadian Engineer*, May 28, 1914), the subject of road design was dealt with by Mr. Robt. A. Meeker, State Highway Engineer for New Jersey. Mr. Meeker touched upon the essential factors: width, alignment, grade and drainage, in the following way:

Width.—The first point to be considered in designing a road is its width. It may be generally stated as axiomatic that the width of roads should be in multiples of eight, this being the width that should be allowed for each vehicle using the road. A road 8 ft. wide might more properly be termed a lane leading to one building or a small group. The next in importance should be 16 ft. in width, in order that two vehicles might have sufficient width in which to pass. The third width, or 24 ft., would permit of two vehicles passing while the third was standing along the side of the road—or two loads of hay or other bulky material to pass. The fourth width, or 32 ft., permits two vehicles to stand along the sides and leaves sufficient space for two other vehicles, moving in opposite directions, to pass each other in safety. These widths refer to the traveled carriageway alone, no allowance whatever being made for the accommodation of pedestrians, nor for any drainage structures.

In order to obtain a roadway of sufficient width to accommodate travel passing in both directions, 24 ft. may well be taken as the minimum allowable, and if there is the prospect of an increase of traffic in the near future, a proper addition to the width of the surface, necessary for the accommodation of the traffic, should be provided for in the original design. It is almost impossible to properly grade and drain a road of less than 24 ft., and the wider the roadway the more easily it is drained, and also maintained, due to the fact that the traffic is distributed over a greater area, and that the surface is more freely exposed to the drying action of the wind and sun, thereby preventing the formation of mud and ruts.

Alignment.—The second problem is that of the location of the line. On a new road this is determined by certain well-defined principles. First, the beginning and ending points should be connected by the most direct line; second, the grades should be kept as low as possible; third, for economy's sake, the line should be so located as to reduce the amount of grading to the minimum, likewise the number and size of the bridges.

The factors governing the departure from a straight line are many. In crossing a ridge we seek the lowest point in the summit, in order to avoid expensive cutting or the alternative of steep grades; in following a valley we keep well up on the hillside, to avoid bridging ravines and small water courses; if we encounter a swamp or pond we can frequently, by swinging the line, save the expense of a heavy fill; a stream may be avoided by diverting the line, thus saving the cost of bridges.

On an old road another set of problems has to be solved; these are chiefly those of expediency. Though a straight line between the termini may not only be the best but also the cheapest, the claims of intermediate communities may be so strong that the line must be diverted from its best course to satisfy the wants of the communities to be served. But through it all, in spite of all of these warring factors, the engineer must never lose sight of the straight level line between two points as his ideal. By keeping this constantly before his mind's eye the results that may be achieved will often surprise even the author.

Grade.—The grade, or the angle which the axis of the road makes with a horizontal line, is the most important economic feature in road design, for upon it depends the amount of material a horse can draw over the road. The results of experiments made both in England and France prove that a horse can haul twice as heavy a load up a 2 per cent. grade as he can up a 6 per cent. grade. That being so, the value of a road for heavy traffic, having a maximum grade of 6 per cent., is only one-half of that having a maximum of 2 per-cent. This fact is often lost sight of in designing new grades, the object of many road officials being to build as many miles of road as possible for a given amount of money, the first cost, and not the ultimate value of the road to the community, being the basis upon which the improvement is made. This cutting down of hills and the filling of valleys or reduction of gradients is no new idea, for Isaiah wrote, over 2,000 years ago, his idea of a perfect highway as follows: "Every valley shall be exalted and every mountain and hill shall be made low; and the crooked shall be made straight, and the rough places plain."

Drainage.—Having laid out your road as straight as possible, and having reduced your grades as much as your funds will permit, the next important problem is is that of drainage. This is of two kinds—surface and subsurface. Surface drainage is both transverse and longitudinal. Every road must be so planned that the water which falls upon its surface will not remain upon or along it. The first object is attained by giving the road a proper crown or cross-section, so that the water may be conveyed quickly to the gutters on the sides. This crown should have the form of the arc of a circle, drawn through three points—the centre of the road and the gutter on either side. The elevation of these points should be in the following ratio: For earth roads a fall of 1 in. per foot from the centre to the gutters; for waterbound macadam, ¾ in. per foot, and for bituminous concrete ½ in. per foot. This form of cross-section permits of the fullest use of the road, and at the same time conveys the water to the gutters without washing the sides or shoulders of the road. The longitudinal surface drainage is taken care of by the gutters, which must be carefully trimmed to conform to the grade of road, all holes being carefully filled and all humps cut off. In fact, the gutters must be as carefully graded as the centre of the road. Proper inlets to bridges crossing the road should always be constructed if the bridge is as wide as the carriageway. In some soils these precautions are not sufficient, and we are then compelled to lay underdrains. These should be placed about 3 ft. inside of the gutter line, for two reasons: First, to intercept the subsurface water before it reaches the middle of the road, and second, to prevent erosion in case the gutters are gullied. The object of underdrains is to cut off the subsurface water before it can get beneath the traveled road; therefore their place is on one or both sides of the paved way.

The second-hand railway equipment business of Jas. T. Gardner, deceased, Chicago, will continue under the name of Jas. T. Gardner, Inc., with the following officers:—M. Gardner, pres.; R. H. Gardner, vice-pres.; A. V. Talbot, sec.; and A. M. Talbot, treas.

Victoria, B.C., has commenced work on the excavation of the ten-mile trench in which the steel pressure pipe for the Sooke Lake waterworks system will be laid from Humpback Reservoir to the city. This work will be rushed ahead in order that no delay may be encountered when the Burrard Engineering Company of Vancouver, to which has been let the contract for the fabrication and laying of the pipe, starts delivering the pipe lengths.

THE FIRST RAILROAD IN AMERICA.

THE pressing need for additional and enlarged transportation facilities to meet the growing demand occasioned by the phenomenal growth of business in all of its departments and branches, presents itself as an issue and problem of far-reaching importance. Apart from this living issue, which is now in process of argument and investigation, it is interesting to review briefly the origin of railroads in America.

In this connection Mr. W. P. Maher, writing in "Railway and Locomotive Engineering," has presented a few statistics and data concerning the origin of railroads in the United States, as given below:

The first railroad constructed in the United States was the Quincy railroad (1826). It was three miles in length and was built to transport granite from the quarry at Quincy to the Neponset River, close to Boston harbor. This railroad was laid upon granite ties eight feet apart. The cars were drawn by horses and the usual load was ten tons. The schedule of this railroad was three miles an hour.

The Baltimore & Ohio Railroad is credited with being the first railroad constructed in the United States operated as "a steam railroad." This is erroneous. As a matter of fact the first railroad planned and constructed in the United States to have for its motive power steam engines was the Charleston & Hamburg Railroad, in the State of South Carolina, connecting the port of Charleston, S.C., with the town of Hamburg, S.C., located on the Savannah River, opposite Augusta, Ga., the distance between Charleston and Hamburg being 136 miles.

On December 6, 1827, the city council of Charleston called a public meeting of citizens. After varied discussion towards the means and ends of constructing a line of railway to run from Charleston to Hamburg, on December 19, the legislature passed an act, chartering the South Carolina Canal and Railroad Company. The directors realized the great importance of employing an engineer having special ability in construction work. They began to look around for a suitable person and engaged the services of Horatio Allen. He immediately proceeded to acquaint himself with the details of affairs as they existed and in two months he presented a report to the company embodying the cost of transportation by horse power and by locomotive power.

In March, 1830, E. L. Miller, a native of Charleston, who had been present at the opening of the Liverpool & Manchester Railroad and who had studied closely Stephenson's engine on that line, offered to construct a locomotive after his own plan. The offer was accepted and Mr. Miller proceeded to West Point, N.Y., and built the engine at the West Point foundry. The engine arrived at Charleston the latter part of October and was placed on the road November 2. It was named "The Best Friend." It made its trial trips December 14 and 15, 1830. In speed and power it exceeded the most sanguine expectations. It pulled six cars with 50 passengers at the rate of 20 miles per hour and with the empty cars it made from 30 to 35 miles an hour.

The engine was regularly used in carrying materials over the line, and also was used in between times to carry excursion parties. "The Best Friend" was the first American built locomotive and the road upon which it ran was the first American railroad to employ steam locomotive power. The engineer who had the honor to operate it was a native of Charleston named Nicholas W. Darrell. Through the carelessness, or perhaps due more to inexperience, the negro fireman gave the engine an overdose of steam and on June 17, 1831, "The Best Friend" exploded.

About this time the chief engineer, Allen, designed an eight-wheel locomotive which he had constructed at the West Point foundry. This locomotive was put on the line in January, 1832. It was named "South Carolina." It was a very powerful machine, and was the first eight-wheel locomotive in the world.

On November 7, 1832, the road was completed and opened for traffic between Charleston and Branchville, a distance of 61 miles. On November 2, 1833, the entire line from Charleston to Hamburg was finished and begun its operations of common carrier. It was the longest line of railroad in the world to be operated solely by steam locomotive power.

In summarizing some of the distinctive features of priority that the Charleston & Hamburg Railroad can claim over its competitors, it may be mentioned: It was the first railroad constructed in the United States, built and planned to be operated by steam locomotive power. Constructing and operating on its road the first American-built locomotive. Having for its first chief engineer the man who ran the first locomotive in America.

We learn that in February, 1835, the splendid locomotive "Edgefield" was making its regular schedule, pulling five passenger cars the distance of 136 miles in seven hours and 20 minutes; that the railroad owned 12 engines, 20 passenger cars and 135 freight cars, and that regular schedules were operated—both freight and passenger, and that depots had been built along the line about 10 to 15 miles apart.

This is, in brief, a historical summary of the first steam railroad built in the United States. This line is now a part of the Southern Railway system.

NOTABLE ITALIAN WATER SUPPLY.

With the completion of the Croce di Monaco tunnel through the Eastern Apennines, which was accomplished recently, the last engineering difficulty in the way of finishing the Pugliese aqueduct has been removed. This aqueduct, which was begun in October, 1899, and will, it is hoped, be completed this autumn, is said to be the greatest hydraulic work of its kind ever undertaken.

By diverting the River Sele, which at present flows into the Tyrrhenian Sea below the Gulf of Naples, its waters are carried through the main range of the Apennines to the Adriatic coast of Italy and delivered to the three arid provinces of Puglia. The aqueduct begins at Caposele, 1,358 feet above sea level, and the main waterway running to the eastern slope of the mountains at Venosa is 132½ miles long, of which 60 miles are cut through the rocky mountains.

At Venosa the supply is divided into three, one branch running to Foggia, another to Bari, and the third to Lecce, in the very heel of Italy. These three main conduits have a total length of 1,000 miles. The distribution among the principal towns and communes has necessitated the laying of 500 miles of piping. One hundred and fifty-two reservoirs, each containing 150,000 cubic metres of water, have been constructed at various points. Two and a-half million people will be benefited by the scheme, and 84,000 small land owners will obtain water for the irrigation of their holdings.

The total cost of the undertaking, which has employed 10,000 for 15 years, has exceeded £6,000,000.

Pine and fir piles that have been in service for 43 years in a railway trestle in Great Salt Lake have, upon inspection, been found perfectly sound, due to thorough impregnation with salt.

The Province of British Columbia has an area of 305,000 sq. mi. and a coast line of 7,000 mi. It has 15,000,000 acres of standing timber. There were 2,250 mi. of railway in operation last year, with 2,304 mi. under construction.

WATER STERILIZATION BY ULTRA-VIOLET RAYS.

A PAPER which is being presented by M. von Recklinghausen at the 31st annual convention of the American Institute of Electrical Engineers in Detroit on June 26th, is based upon the sterilization of water by ultra-violet rays of the mercury-vapor quartz lamp. It refers to the historical development of mercury lamp water sterilizers and the development of pistol lamps for large sterilizing units. The sterilization of water is a field that has developed for the application of electricity during the past five years. The experimental work has been done chiefly in France and with it M. von Recklinghausen has been prominently identified. His paper deals particularly with the work done by him in collaboration with Messrs. Henri and Helbonner at the physiological laboratory of the Sorbonne University. A considerable portion of it is devoted to a study of the economical use of ultra-violet rays for this purpose and the best temperature to be employed in the luminous part of the lamp. The measurement of ultra-violet power, based on physical, chemical and bacteriological reactions is explained and these reactions are compared.

It is found best to choose as a unit some value of the particular effect of the rays which concerns the work in hand, and of the four different methods of examining the power of the ultra-violet spectrum the bactericidal or abiotic action is found well suited in the sterilization of water. However, in choosing a unit of bactericidal reaction it was found that cultures of microbes vary so much with age and other conditions that it was impossible to get sufficiently constant results upon which to base a unit reaction. It has been necessary, therefore, to determine the sensibility of the reactive material; i.e., the germ culture on hand, by exposing samples of it to the light of a lamp which has been standardized. This has led to the creation of a laboratory standard lamp to be operated so that it will always produce the same amount of ultra-violet rays. The experimental method of procedure consisted in taking a drop of the culture, exposing it at a definite distance from the lamp, counting the seconds necessary to render them motionless and comparing the

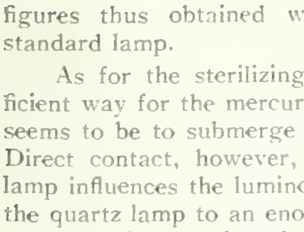


Fig. 1.

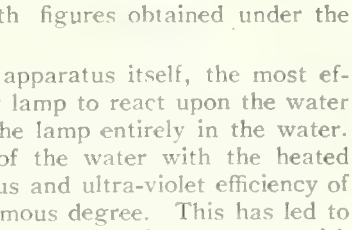


Fig. 2.

figures thus obtained with figures obtained under the standard lamp.

As for the sterilizing apparatus itself, the most efficient way for the mercury lamp to react upon the water seems to be to submerge the lamp entirely in the water. Direct contact, however, of the water with the heated lamp influences the luminous and ultra-violet efficiency of the quartz lamp to an enormous degree. This has led to a means of protecting the lamp from direct contact with the water by fusing over the former a wide quartz jacket. This system has been adopted with modern apparatus. Difficulties arose in the manufacture of such jacketed lamps, however, resulting in the construction of what are known as pistol lamps. Another method is to let the water circulate in such a way around the lamp that it will not come into contact with it, receiving, nevertheless, all the rays emitted by it. Again, where it is more a question of convenience and less a question of efficiency the simplest method is to place the lamp above the water as close as possible to its surface, but reflectors placed above such lamps have a low efficiency in the reflection of ultra-violet rays.

Water bacteria are killed in as short a time as 1/20th of a second at a distance of 1 to 2 centimeters from the powerful ultra-violet ray lamps. Water being practically as transparent to the rays as air itself, if a germ floats in the water it will be annihilated by getting into the illuminated zone, the condition for this being that no suspended matter is contained in the water which would form a shield for the germ.

Water for this sterilization has, therefore, in most cases to be filtered before being submitted to the sterilizing action of the rays. However, even very good filters will allow some microscopic matter to pass. It is much more effective, as shown by experiments, to stir up such water while it is going through the illuminated zone so as to turn over and over any particles which otherwise might allow microbes to pass by under cover. Baffle arrangements are built in for this purpose of stirring up the water. For the same reason, also, it is best to pass the water through several illuminating zones, which can easily be done by leading the water several times towards the same source of light, or by passing it successively under several sources of light.

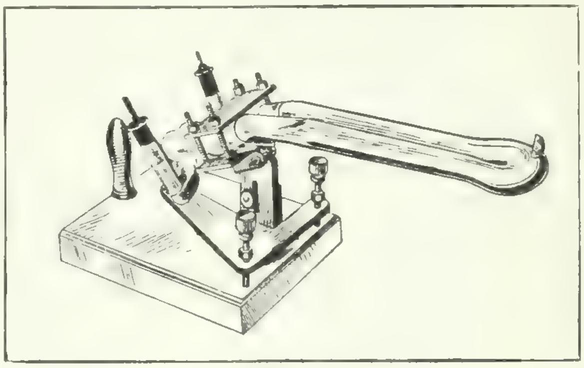


Fig. 3.

Typical Installations.—The largest unit ever built was set up about two years ago in the city of Luneville, France, to sterilize the city water supply. It consists of a flume into the sides of which ten 500-volt pistol lamp equipments are inserted. These equipments consist of metal boxes for the starting of the lamps (the latest types of them contain also the rheostats). The boxes are equipped on the inside with a stuffing box arrangement holding the quartz protective tube which protrudes into the water. The lamps are lit in the starting boxes and then their luminous parts are inserted into the protective tubes, so that the light emitted from the lamp enters the water.

The raw water fed into this plant comes from the Meurthe River and contains sometimes as high as 60,000 germs per cu. cm. It is clarified by a series of roughing filters and one filter. After this it is physically in fairly good condition, being very poor in suspended matter, but having from time to time fairly deep color (up to 45 U.S. standard) in solution. The germ contents are sometimes as high as 1,000 per cu. cm. in this water. It is then passed through the sterilizing unit described above, coming under the influence of the light from one to two minutes altogether, according to the number of lamps running. This number (sometimes only 4) depends on the

physical condition of the water, which is easily observed. The bacteriological tests of the water when leaving the sterilizer rarely show more than 10 germs per cu. cm., and are often zero. Bacterium coli is always eliminated. Not only are the bacteriological tests satisfactory; the health of the community has improved considerably. Typhoid used to cause from 70 to 160 deaths annually; it is now practically eliminated, there being no cases at all this year.

Another typical installation was made in New York lately for the purification of the water of a swimming pool, which is naturally exposed to continuous pollution from the bathers. The water in this case is circulated continually through a filter to take out suspended matter and then it passes through the ultra-violet ray sterilizer. This apparatus is similar to the Luneville unit except for its size, as it contains only two 220-volt pistol lamps. It is rated at 175,000 gallons capacity per day. Tests at the outlet of the sterilizer show only a few germs, and tests of the water going to the purifying apparatus have improved from 6,000 germs per cu. cm. to about 350 germs per cu. cm. since the introduction of the ultra-violet ray apparatus.

Consumption of Electric Energy.—The smallest lamp used in the above apparatus operates at 110 volts with two amperes. The largest made so far is for 500 volts, 2.5 amperes. The largest apparatus built contains ten of the last-mentioned lamps. The power consumption in such a case, with a very large safety coefficient for the sterilization, is between 50 and 130 kw.-hr. per million gallons of water. This amount of power is evidently not very great but it will always do something to smooth out the load curve of a power station, as, in most cases, such apparatus will be operated continuously. Many installations of this kind have been made in Europe for both small and large waterworks, and they are operating very successfully. Their simplicity and rapidity of action are highly satisfactory.

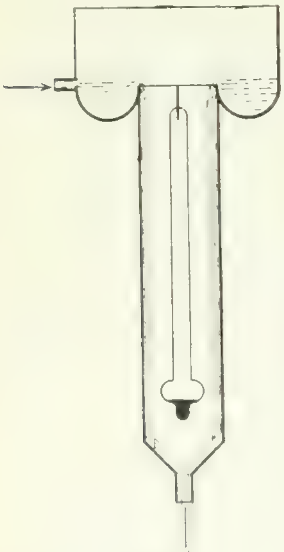


Fig. 4.

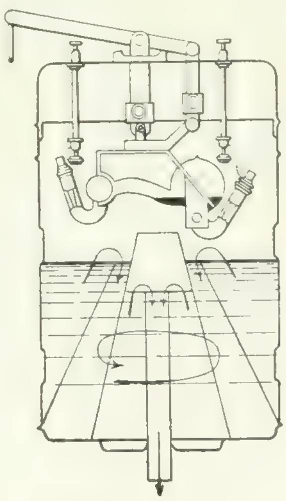
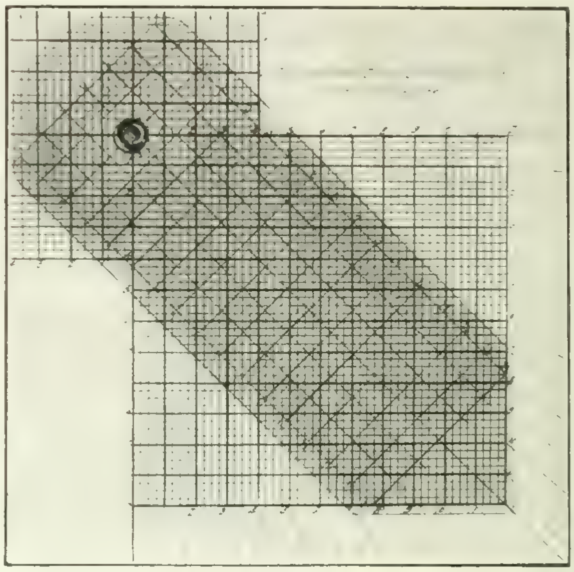


Fig. 5.

The accompanying illustrations from M. von Recklinghausen's paper, convey an idea of the nature of the apparatus and its use. Fig. 1 shows the entirely submerged lamp used in the experiments of Courmont and Nogier, and Fig. 2 shows the position of the quartz jacket used to prevent contact of water with the light-giving portion of the lamp. Fig. 3 is an illustration of the so-called pistol lamp, which allows all the light to enter the water, at the same time providing a removable lamp. Figs. 4 and 5 show several methods of circulating the water so as to be thoroughly penetrated by the ultra-violet rays, although not coming into contact with the lamp.

NEW BEVEL JOINT DETAILER.

A useful and ingenious little instrument for the detailing of bevelled joints in structural steel work has been designed by W. J. Donley and B. H. Williamson of the Canadian Allis-Chalmers, Limited, Toronto. It is extremely simple in operation, promises to be a great time saver and is at the same time very accurate. It does away with the necessity of making detail layouts to a great extent and has a large field of usefulness to both checkers and detailers.



The accompanying illustration gives a fair idea of the general appearance of the device. It is called the Lightning bevel joint detailer. It is 9 in. square and consists of a back of white celluloid and a movable arm of transparent celluloid, both of which are graduated to half-size scale. The instrument has been thoroughly tried out on the detailing of truss member joints, lateral and partial connections and various other classes of work. It has been found so satisfactory in every case that patents will be applied for and the instrument put on the market.

The Ontario Railway and Municipal Board appointed some little time ago a board of experts to investigate the traffic conditions in Toronto with regard to the street railway system and to make some recommendations for the improvement of the same. A report has been submitted recommending improvement to the extent of an estimated expenditure of $2,950,000. Of this amount $2,160,000 covers additional cars, 180 2-car trains being recommended; $250,000 pertains to track extensions and specials, and $540,000 includes power machinery transmission equipment. The report will be considered at an early date by the Board and the Toronto Railway Co. jointly.

The contract was recently awarded to Messrs. Naylor Bros., of Victoria, for a reinforced concrete bridge of the trestle type to span a ravine about 280 ft. in width and 75 ft. in depth over McCartney Creek, B.C. The new bridge will be located about 4 miles east of the city of North Vancouver, on the Keith Road, which is forming part of the Marine Drive trunk road scheme for the north shore of Burrard Inlet, inaugurated by the District Council in 1911. The bridge will have a 24-ft. roadway, with provision for sidewalks, water mains, etc. The contractors' price was $17,800. The work is well in hand, and the date set forth for completion is July 22nd. It is being built for the Corporation of North Vancouver.

THE FRENCH SYSTEM OF ROAD MAINTENANCE.

At the recent Good Roads Congress in Montreal and elsewhere frequent references have been made to the systematic organization of forces which has attended the construction and maintenance of roads in France. The superiority and completeness of the French road system has world-wide recognition. The technical and administrative organizations in charge of road development in that country are looked upon throughout America as being of the most efficient, and it is generally maintained that such is an evidence of the advantages arising from a systematic organization properly trained and properly equipped for such work.

This French road system was described by Mr. Jean de Pulligny, chief engineer, bridges and roads, and director of the "Mission Francaise d'Ingenieurs aux Etats-Unis," New York City, in a discussion on road construction and maintenance before the American Society of Civil Engineers last year, and appearing in the Proceedings of the Society for September, 1913. From it the following synopsis is given:

The national main highways which connect Paris with the large cities and the frontiers are constructed and maintained by the central government. These main highways (Routes Nationales) were built more than 100 years ago, when scarcely any roads were to be found in other countries, for military purposes and for carrying the royal mail. Their total length is about 24,000 miles, and the annual appropriation for their reconstruction and maintenance is $6,500,000. Since the completion of railways the national main highways are not considered as having as much importance as the other roads of the country, which amount to 339,500 miles in length, and require an annual expenditure of $37,400,000. These roads include mainly Chemins Vicinaux de Grande Communication, connecting the cities and villages, and the less important Chemins Vicinaux Ordinaires, which connect farms with the next village or the nearest city. The Chemins Ruraux are roads connecting one farm with another or connecting farms with more important roads.

Technical Organization.—France, which has a gross area of 207,000 square miles, is divided into 86 territorial units called Departments, having an average area of about 24,000 square miles. The 86 Departments (plus Belfort territory) are divided into 275 Arrondissements and the 275 Arrondissements are composed of 2,325 Cantons, which are divided into 36,222 Communes. Each Department is a political unit, and is a unit for several public services. It has a governor appointed by the central government, called a Prefet, and an elective body called the Conseil Général. It has also certain revenues produced by taxes, the appropriation of which is decided by the Conseil Général.

All the road system of Chemins Vicinaux is managed by the Prefet, and the expenditure is voted by the Conseil Général, the central government having practically nothing to do with it. The Prefet, of course, does not manage the road system himself, but through a centralized body of competent technical men. In about half the Departments the work has been entrusted by the Conseils Généraux to the body of government engineers—Ingenieurs des Ponts et Chaussées—to which the writer has the honor to belong. These roads comprise only a small part of their work. They also have in charge the national main highways and the various civil engineering works which are administered by the French government, including all the inland navigation works, canals and canalized rivers, all the ports, docks, harbors, sea shores and lighthouses, and the close inspection maintained by the French government over the railroads, with reference to safety, regularity and rates, and also to secure a proper maintenance of the railroad property which is only entrusted to the railroad companies for a definite period, at the expiration of which such property will be returned to the government.

In the other half of the Departments (exactly forty-six) special technical bodies have been organized, which are, of course, quite outside of politics. They include a chief road engineer, residing at the capital of the Department, near the Prefet, and having charge of all the Chemins Vicinaux of the Department.

Each Department is divided into three or four political districts headed by a Sous Prefet, and called an Arrondissement. In each capital of each district there resides a district road engineer, who is under the orders of the chief road engineer and has charge of all the Chemins Vicinaux of the Arrondissement.

Each Arrondissement is divided into eight or nine judicial districts, named Cantons, each of which also has its small capital, in which resides an assistant road engineer who has charge of all Chemins Vicinaux included in the Canton. He is under the orders of the district road engineer. Finally, all roads in a Canton are divided into sections, each having an average length of 4 miles, and on each of these sections the celebrated French Cantonnier, or road patrolman, works constantly with his pickaxe, shovel, shrub and wheelbarrow. These Cantonniers are under the orders of the assistant road engineer. A few of them have shorter sections and they look after the work of their neighbors, as foremen (Chefs Cantonniers). The Cantonniers are simple laborers, generally of agricultural training, and are not required to have any special knowledge in order to enter the service. They are only expected to be of respectable behavior, to be able to read and write, and to be steady and trustworthy workers.

It is evident that every square yard of French roads is under the permanent care of a patrolman, of a chief patrolman, of an assistant road engineer, of a district road engineer, and of a chief road engineer. All these men form a hierarchy, with a Prefet as the head. Any complaint by the people, or their representatives, to the Prefet is properly attended to. All members of the road service, from the patrolman to the chief engineer, work under a civil service law. When they have once entered the service they can only be dismissed in case of serious misbehavior. They are promoted at regular intervals, with better pay, and when they retire, after thirty years' work, they get an old age pension. Most of the patrolmen lack sufficient knowledge to become assistant engineers. The latter are recruited by public competitive examinations, taking place every two or three years, from among young men who have studied, by themselves or in school, the necessary subjects, such as the elements of mathematics, surveying, drafting, designing, and road construction and maintenance. The boys employed as helpers for drafting, designing and surveying in the offices of road engineers also generally undergo these public examinations. Their practical experience serves them well, and most of them succeed. The district engineers are generally chosen from among the most able and experienced of the assistant engineers who have had many years of service. The chief engineer for the whole Department may have been previously a district engineer, but it is not obligatory. In some cases he was formerly a civil engineer, a graduate from one of the principal schools, an architect, or an Ingenieur des Ponts et Chaussées.

Table I. shows the number of chief, district and assistant road engineers in each of the 46 Departments where a special road service has been organized.

Table I.—Number of Engineers, Etc., on French Roads in Departments Having a Special Road Service.

Departments.	Chief road engineers.	District road engineers.	Assistant road engineers.	Field and office graduate assistants.
Ain	1	5	41	46
Aisne	1	6	55	7
Hautes Alpes	1	4	22	8
Ardennes	1	5	32	6
Ariège	1	4	22	11
Aude	1	4	49	16
Calvados	1	6	34	26
Cher	1	2	21	9
Corrèze	1	2	33	7
Creuse	1	4	27	3
Dordogne	1	5	42	21
Doubs	1	5	29	11
Eure	1	7	44	12
Gard	1	4	36	10
Haute Garonne	1	5	48	16
Gironde	1	10	48	48
Hérault	1	5	49	15
Ille-et-Vilaine	1	7	37	16
Indre-et-Loire	1	3	25	15
Isère	1	7	52	30
Jura	1	5	36	10
Landes	1	4	25	9
Lozère	1	2	19	12
Manche	1	6	51	14
Haute Marne	1	4	33	3
Meuse	1	4	39	14
Morbihan	1	6	25	10
Nièvre	1	3	30	9
Nord	1	8	53	28
Orne	1	5	36	15
Puy-de-Dôme	1	5	53	..
Pyrénées-Orientales	1	2	25	6
Haut Rhin	1	..	5	3
Rhône	1	3	32	29
Haute Saône	1	3	34	4
Sarthe	1	5	34	13
Seine-et-Oise	1	7	51	17
Seine-Inférieure	1	5	50	29
Deux Sèvres	1	4	31	12
Somme	1	6	45	15
Tarn	1	5	28	18
Tarn-et-Garonne	1	2	20	13
Vendée	1	8	26	6
Vienne	1	6	32	15
Vosges	1	6	34	6
Yonne	1	6	42	6

Salaries.—As examples, statements will be given concerning the salaries of the road engineers and assistants in two Departments: In Seine-et-Marne (population = 358,325; area = 2,300 sq. mi.) the service is entrusted to the Ingenieurs des Ponts et Chaussées; in Seine-et-Oise (population = 707,325; area = 2,170 sq. mi.) there is a special service of departmental road engineers.

Department of Seine-et-Marne (Road Service Entrusted to the Government Civil Engineers).—The body of government civil engineers (Ponts et Chaussées) was created on February 1st, 1716, and the Ecole des Ponts et Chaussées, for the education of such engineers, was founded in 1750.

The classes and salaries in the body of the Ponts et Chaussées are as follows:—

	Annual salary, according to seniority.
Inspecteur Général	$2,900 to $3,400
Ingénieur en Chef	1,900 to 2,300
Ingénieur Ordinaire	965 to 1,350

In addition to their government work, these engineers are allowed to work for departments, cities, chambers of commerce, etc. From this and from other supplements given by the state itself nearly all engineers earn at least $200 yearly. Many earn more, and the supplements of a few equal or exceed their salary.

The state salaries of their assistants are as follows:

Conducteurs (assistant engineers), $425 to $965 per annum, according to seniority.

Commis (office and field graduate assistants), $280 to $675 per annum, according to seniority.

After 30 years of employment, all engineers and assistants are granted an old-age pension of about one-half of the highest salary they have obtained. Besides their state salary and supplements, the engineers and their assistants receive the following fees for their department road service:

Ponts et Chaussées:	Annual fee.
Chief engineer	$1,150
District engineer	575
	According to seniority.
Conducteurs (assistant engineers)	$123 to $192
Office assistants: Head clerks	210 to 385
Typewriters and field and office assistants	50 to 150

The patrolmen are special for the departmental road service. Their monthly salary is as follows, according to seniority:

Chief patrolman	$25 to $27
Patrolman	19 to 21

When these officials are ordered to travel outside the limits of the city in which they reside they receive traveling expenses.

During 1912 the total salaries, traveling and sundry expenses for the road officials, including patrolmen, in the Department of Seine-et-Marne, amounted to $28,000.

Department of Seine-et-Oise (Special Departmental Road Service).—The salaries and old-age pensions after 30 years' service are as follows:

	Annual salary.			Annual pension after 30 years' service.
Agent voyer en chef (chief road engineer)			$1,920	$1,440
District engineer	$960	to	1,100	825
Assistant engineer	480	to	850	640
Office and field graduate assistants	280	to	575	430
	Monthly salary.			
Chief patrolman	$22	to	$25	$121
Patrolman	16.50	to	19	100

Many employees also receive various supplements for the high cost of living in certain cities, help to large families, extra work, traveling expenses, etc.

The total of these expenses for the office staff in the Department during 1911 was $10,400. The total expense for patrolmen and chief patrolmen, including all sundry expenses, was $72,500.

These two Departments are near Paris, where the cost of living and all salaries are high. In many other Departments, the salaries would be smaller by 10 per cent., and, in a few, by 25 per cent.

The total expense for the Chemins Vicinaux of all classes during 1910 amounted to $37,500,000, as follows:

Regular maintenance	$26,355,000
General repairs	2,100,000
Building new roads	4,420,000
Land acquisitions	890,000
Sundry expenses	335,000
Salaries and general expenses	3,400,000
Total	$37,500,000

Administration and Financial Organization.—The engineers of the road service not only build new roads and maintain existing ones, but take an important part in the administrative and financial working of the road system.

The assistant engineers walk nearly all day on the roads of their district, or they may ride on a bicycle, in a carriage, or in an automobile. They constantly meet the elected mayors of the small towns, and they know all the needs of the people. Knowing also approximately the available resources for the coming year, they prepare for each township and for each road of their district a scheme for maintenance expenses and for the building of new roads. They send their reports to the district engineer who sums them up and makes any changes he deems necessary.

Table II.—Mileage of Chemins Vicinaux.

Condition.	De Grande Commun-ication. Miles.	D'Inter-et Commun. Miles.	Ordin-aires. Miles.	Totals. Miles.
Accepted and regularly maintained	107,000	47,200	178,000	332,200
Under construction	287	302	6,700	7,289
Only designed	970	1,770	53,500	56,240
Total	108,257	49,272	238,200	395,729

All the district engineers forward their reports to the chief engineer, who designs a general scheme for the maintenance and building of new roads in the whole Department. Each town or village has its small elective body, which is called to deliberate on the road work and on the expense in which it is concerned. A bill for this scheme is then discussed by the Department's Legislature in its annual session, and may undergo some changes. The appropriation is finally voted, and the works are then carried out with no more intervention on the part of the political representatives, the road engineers acting only under the authority of the Prefet. The expense is levied on the town or village as a public tax, even if the people do not approve of it.

The Chemins Vicinaux, thus taken care of by the Department, are the Chemins de Grand Communication which connect two or more towns or villages. In such cases it is admitted that the maintenance of the roads must not be entrusted to the townships, because one town might do its share of the work and suffer because the other town would not do the same; therefore, the money is provided by the town taxes, but the direction of the work is assumed by the Department.

The construction of new Chemins de Grande Communication is undertaken by the Department for the same reason, but, in this case, there is an important difference as to the origin of the funds. Instead of providing all the money from municipal revenues, the town only give a part of it, and the remainder is appropriated by the department from its share of certain taxes, the amount of which is divided between the Central State, the department and the towns. The sharing of the expense between the town and the department is provided in accord with definite rules, in which both the needs of the township and its resources are considered.

The total revenue produced by certain taxes is supposed to be an index of the comparative wealth of the townships, and the area of their district is considered as a measure of their needs for roads. The revenue being divided by the area, the quotient is considered as an index number by which the townships are classified, and, for a certain index number, they may receive a definite percentage of help from the department, as high as 85 per cent. for a very poor township with a very wide area needing very long roads.

A similar classification is made in the Departments on the same double basis of wealth and area, and an annual appropriation from the Central Government's fund is divided between the departments as a National aid for the construction of their roads. This appropriation amounted to only $2,000,000 in 1910. It has been larger in certain other years.

Such is the technical, administrative, and financial system, and it has worked satisfactorily in France for nearly a century. It only applies to the Chemins Vicinaux de Grande Communication which concern two or more towns or villages.

As for the Chemins Vicinaux Ordinaries, Chemins Ruraux, and Rues (streets) which concern only one town or village, the mayors are free to build and maintain these roads out of the municipal funds, as they wish. In fact, all the villages and small towns voluntarily entrust their road work to the assistant road engineer whom they see daily, and he does it for a small fee. If a town is more important, and if it has a few municipal works of sewerage, water, gas, or electricity, to be looked after besides the road work, a special engineer is appointed who takes care of the whole. If a city is still more important, one or more municipal engineering services are organized. The municipal engineering services of the city of Paris are extremely complete, and their organization is most remarkable, from every point of view.

A few words may be devoted to two other divisions made by the laws of the past in reference to the French roads, namely, the Routes Departmentales and the Chemins d'Interet Commun, which are nothing more than types of Chemins de Grande Communication.

The difference in names carries a few changes in the rules governing the management of these roads and the corresponding funds. These changes are not direct toward simplicity. For many years the tendency in all departments has been to have only one class of roads, the Chemins de Grande Communication. No more Chemins d'Interet Commun are created, and every year some Routes Departmentales are dropped from the official lists, and are afterward considered as Chemins de Grande Communication. The length of the Routes Departmentales has decreased from 29,500 miles, in 1869, to 8,100 at the present time.

On January 1st, 1911, the 395,729 miles of Chemins Vicinaux were distributed as shown in Table II.

As previously stated, there are also 8,100 miles of Routes Departmentales and 24,000 miles of Routes Nationales, forming a grand total of 428,000 miles of roads of all classes.

The building and maintenance expenses of the Chemins Vicinaux have varied according to time and place, but the figures in Table III. give an idea of what

they usually cost. The lengths considered include only the roads accepted or under construction.

For comparison the figures relating to the Routes Nationales have been reproduced, and also some for the Routes Departmentales.

The total length of French roads is nearly 372,000 miles, and their total cost may be considered roughly as more than $1,500,000,000. The difference between these 372,000 miles and the total of 428,000 previously given, results from the omission from Table III. of the 56,240 miles which have only been designed. There are also about 155,000 miles of farm roads, with or without ditches, metaled roadway, and maintenance.

The annual maintenance of the 372,000 miles of regular roads requires nearly $45,500,000, the share of the Central Government being $6,500,000 and that of the 86 Departments nearly $39,000,000. This shows a contribution of about one dollar per head of population.

Table III.—Usual Cost of French Roads.

		Av. Width, in yards		Approximate cost of :— Building.			Annual maintenance.		
Classes	Total length, in miles.	Ditches included.	Ditches excluded.	Total expense.	Per mile	Per square yard, ditches included.	Total expense.	Per mile.	Per square yard, ditches excluded.
Routes Nationales	23,800	20	15½	$ 300,000,000	$12,600	$0.36	$ 6,500,000	$270	$0.0099
Routes Departmentales ...	8,100	14	11	63,000,000	7,750	0.32	1,500,000	185	0.0095
Chemins Vicinaux de Grande Communication	107,300	10¼	8½	665,000,000	6,200	0.33	16,900,000	157	0.0105
D'Interet Commun	47,500	10	7½	178,000,000	3,750	0.21	6,000,000	126	0.0095
Ordinaires	184,700	9	6½	457,000,000	2,470	0.16	14,500,000	78	0.0068
Totals	371,700	....	....	$1,663,000,000	....	....	$45,400,000	....	......

PRIME MOVERS.

In the proceedings of the American Institute of Electrical Engineers appears a paper, entitled "The Present Status of Prime Movers," to be read on June 25th at the 31st annual convention of the Institute in Detroit. This paper, by H. G. Stott, R. J. S. Pigott and W. S. Gorsuch, deals with the present status of heat engines and hydrographic turbines in commercial use at the present time for the conversion of the energy found in fuel and water into mechanical power for the production of electric energy. The paper compares the various types as to relative importance, capacity, efficiency, weight, cost and economy. The prime movers are divided as follows: (1) reciprocating steam engine, (2) steam turbine, (3) gas engine, (4) oil engine, (5) hydrographic turbine. Each is dealt with separately and illustrated by curves showing the above characteristics. At the conclusion of the paper a section devoted to finance and economics also contains a number of curves, which show the investment and fuel costs of the different heat engine units, on the basis of percentage of normal full-load rating of machines.

FIRE DAMAGE TO STEEL BRIDGES.

Serious damage to several steel viaducts in the lumber district of Cleveland, Ohio, was due to a fire which swept over approximately 15 acres, destroying about 15,000,000 ft. of lumber. These two viaducts, in their condition as a result of the conflagration, have provided a subject of interesting discussion for engineers. One of them, the Central Viaduct, built for the city in 1887-88, is 2,835 ft. in length, and consists of pin-connected Pratt deck trusses, with a through steel truss river span. Under it ran a railway viaduct, built in 1905-06. It is about 3,000 ft. long, and consists of a roller lift, a through plate-girder, and several deck plate-girders.

As a result of the fire about 500 ft. of the latter viaduct was seriously affected. The foundation piers were badly disintegrated and many of the steel members distorted and buckled, although no part of it fell.

The Central Viaduct received more serious injury, in that about 270 ft. of it at a point where it was approximately 90 ft. above the ground, broke away and fell across the railway viaduct.

The Waterworks Department of the City of London, Ont., has a total of 2,115 water meters now in use, 451 of which were installed during 1913 and 376 in 1912.

The city of Toronto will shortly submit to its ratepayers a by-law to permit the acquiring of $300,000 for the purpose of purchasing motor buses to serve outlying districts. Full and detailed information regarding the proposal is now being prepared prior to placing the matter before the people.

The new Lake Shore line of the C.P.R. will be in readiness for passenger traffic on June 29. A freight business is being tentatively carried on. This new line will give practically a new route between Montreal and Toronto, and will greatly facilitate in handling the traffic, passenger and freight, which passes through this territory. The work was commenced about two years ago, and entailed a cost of nearly twelve millions of dollars.

A report from New York shows that the unfilled tonnage of the United States Steel Corporation on May 31 totalled 3,998,160 tons, a decrease of 278,908 tons over April.

The Pitt Meadows Oil Company, Vancouver, B.C., whose properties are about 25 miles from Vancouver, has secured oil leases on land in that district totalling 1,920 acres, and has also taken over a well formerly owned by a Vancouver syndicate, comprising, among others, W. I. Paterson, Dr. Robert Telford and T. F. Paterson.

The city of Calgary has under construction this year about 150,000 sq. yds. of asphaltic concrete pavement, about 3,000 sq. yds. of stone block, and about 800 sq. yds. of vitrified brick. These figures are in addition to those which were published in *The Canadian Engineer* for May 21st, 1914, which issue contained a summary of the present season's paving work throughout Canada.

Editorial

GRADE SEPARATION IN HAMILTON.

As a result of the recent decision of the Supreme Court that the Board of Railway Commissioners had not the power by virtue of the Railway Act to order the Toronto, Hamilton and Buffalo Railway to unite with the Grand Trunk Railway and the proposed Canadian Northern Railway to use a common right-of-way and union station in the city of Hamilton, the question of grade separation at once presents itself.

For several years an agitation has been on foot in Hamilton against the present location of the T. H. & B. in the southern and residential section of the city. A common right-of-way scheme was presented to the railways by the city, the G.T.R. and C.N.R. signifying their willingness to consider it, but the T. H. & B. refusing to do so. Then the city went ahead with the preparation of plans and estimates for diverting the latter's track, and applied to the Railway Commission for an order. The question as to whether the Board had power to order the T. H. & B. to remove its tracks from Hunter Street, was subsequently taken to the Supreme Court for a decision. According to it, the Board of Railway Commissioners has not the power, on an application from the city, to make an order directing the T. H. & B. to divert its line from its present location to some other location.

Failing in this, matters stand largely as outlined in *The Canadian Engineer* for September 4th, 1913. Doubtless the depression plan will be taken up forthwith. A plan developed by the city, provides for depressing the tracks of the T. H. & B. at an estimated cost of $1,200,000, in addition to $310,000 land damages. Another depression plan, prepared by Westinghouse, Church, Kerr and Company, and submitted by the railway company, entails an estimated cost of $2,940,000, exclusive of land damages. The same company estimates the cost of elevating the tracks at $760,000. In view, however, of the fact that a portion of the present line is already depressed at the western entrance into the city, a depression scheme will, in all probability, be given early consideration.

PRESERVING ENGINEERING LITERATURE.

The value to the engineer of a library of technical information is so universally recognized in all the branches of the profession that none can contest the arguments in favor of the establishment of such by the individual or the organization of which he forms a part. Everyone is aware that accurate information is as essential to the success of engineering work as a compass is to navigation. In its investigation, design and construction, there must be no empiricism or loose approximations. As one writer has said, information is as necessary a tool in engineering enterprises as the mallet and chisel are in the work of an artisan. Besides, through the medium of print one acquires a knowledge of what others are doing and how—as valuable an asset in a profession as in a competitive business.

With the close of the half year, some weekly engineering journals complete another addition to their standardized volumes, and the thought is in order of immediately binding them for preservation and for facilitating reference when occasion requires. The practice of preserving copies for the purpose of having them bound at the end of the half year is one which should be encouraged and its importance emphasized. Requests from readers for back copies to complete volumes are frequent, and it is regrettable that occasionally these requests cannot be complied with owing to the particular issues being out of print. The result is that the volume is either left unbound or bound in an incomplete state. The wisdom of having a place for each journal and of keeping every copy in its place is evident. Now is the time to begin.

It is not the best thing to do to clip articles from journals for the purpose of filing them. While space on the book-shelf may be saved, and articles on like subjects may be kept together in a single file, it is, in the long run, a waste of time, besides destroying the value of the copy itself. In cases of miscellaneous periodicals which contain, only occasionally, articles of value to the engineer, such a procedure may be advisable, but for the regular engineering and technical journals it is an inefficient method.

One cannot foretell whether articles that are thereby being destroyed, will not attain equal or greater value at some future time than those that are being preserved. No one is so proficient in prophecy as to clearly define what should or need not be clipped for future use. One's range of interests is apt to expand or change entirely as time goes on.

Taking it for granted, therefore, that an engineering journal is not to be read like a newspaper and carelessly thrown aside, there are several important points to keep in mind: When the weekly copy arrives, look it over carefully; examine the index page; clip it (and it only), as suggested in our issue of June 4th. Then place the copy with the previous issues, returning it there whenever it is taken from its place and referred to. When July 1st or January 1st comes round, call in the bookbinder.

HIGHWAY ENGINEERING IN GREAT BRITAIN.

With the advent of mechanically propelled traffic, which has multiplied at a great rate in England during the last ten years, and the discovery that such traffic is highly destructive to road surfaces, especially to those made in waterbound macadam, a serious problem has arisen as to what is an economical form of road paving which is suitable for carrying the new form of traffic. For it is admitted by all English road engineers that waterbound macadam is incapable of withstanding heavy motor propelled traffic, while for light motor traffic it is not economical. On rural main roads its life may, however, be extended by sealing the surface against attritive and weather action by coating it with tar or some tar compounds which have been introduced by commercial firms. Each year, therefore, in most highway districts in England the area of waterbound macadam roads which is protected by a surface dressing of tar is extended and—it is safe to prophecy—that within a measurable number of years waterbound macadam will have disappeared from main roads in England.

RUN-OFF FROM SEWERED AREAS.

In May, 1907, the sanitary section of the Boston Society of Civil Engineers appointed a committee to investigate the above subject. The committee submitted a preliminary report early in 1908, designed particularly to describe the apparatus needed for the gauging of rainfall and run-off. This report offered many valuable suggestions for engineers contemplating the establishment of such apparatus. It has been followed by four progress reports bringing out the difficulties of maintaining gauging stations and of properly interpreting the results of gaugings. It has finally transpired that the committee has brought together all of the gaugings which it has been able to secure and has made such interpretation of the results as is practicable. This final report has been published in the June, 1914, Journal of the Society. It is divided into three main parts: methods of measuring precipitation; methods of measuring run-off, and results of measurements of rainfall and run-off, showing relation between precipitation and flow in sewers.

Methods of Measuring Precipitation.—The automatic or recording rain gauge is the only type which is of use in studies of this character, not only because it is essential that records be taken at the time storms occur, whether that be during the night or at other times when observers might not be on duty, but also and especially because it is the rate of rainfall, rather than total quantity, in which we are interested in studies of this kind. This point is so fully recognized that it is not necessary to do more than refer to it at this time.

A point not always recognized in connection with automatic rain gauges is the great importance of a good clock movement which can be closely and accurately regulated. In comparing the records of several rain gauges or the records of rain gauges with those of sewer gauges, the question of time is one of much importance. The correct time of starting a new gauge sheet and of removing the sheet from the gauge should always be distinctly marked upon the chart. With this information available, it may be possible to adjust the error so as to tell moderately closely the time of occurrence of a storm and the time occupied in travel of the storm.

With all commercial rain gauges on the market, the only method of estimating the time is by noting the position of the pen upon the chart. It is seldom possible to estimate the time closer than five minutes, and frequently it is difficult to estimate it closer than fifteen minutes. It is, therefore, a difficult matter to regulate the clock, or to compare the time indicated by two or more gauges. This would be greatly simplified if all gauges of this type were furnished with clock dials and hands, in addition to the ordinary regulator, so that it might be possible to adjust the clock to the correct time and to keep the clocks of several gauges properly synchronized. In large and important works the possibility of electrical operation of the clocks, thus insuring their keeping proper time and being absolutely synchronized, is worthy of consideration.

The report then enumerates and describes the construction and methods of operation of the principal types of automatic rain gauges, including the Fergusson, Draper, Freiz, Queen, Richard, Marvin, Fitzgerald and Hellman.

Measurement of Run-off.—A measurement of the actual volume of storm water run-off in sewers is not usually practicable. Weirs installed in the sewers themselves are objectionable on the score of the head required [illegible] because they cause a retardation of velocity and retention of sediment; it is also difficult to arrange weirs which shall give satisfactory results under wide variations of flow, and frequently with high velocities of approach. Venturi meters are expensive if furnished with recorders, which are indispensible in studies of storm flow; they have an insufficient range for measuring the wide fluctuations which are likely to occur; and as they must usually be set in inverted siphons in order to register properly, their installation in sewers already built involves some difficulties. Current meters for continuously recording the flow of sewage are not ordinarily practicable on account of the foreign material in the sewage, which is likely to clog the meter, or otherwise derange it. As a result, gaugings, so-called, of storm-water flows in sewers, have almost invariably been made by recording the level of the sewage flowing and computing the quantity of flow, using Kutter's formula, usually with an assumed coefficient of roughness. In order to compute the flowing in the sewer from observations of this kind, it is necessary to know the cross-section of the flowing stream, the slope, and the coefficient of roughness. The former can be readily computed from the known or measured cross-section of the sewer, having given the elevation of the surface of the sewage, which is easily obtained from a record of the water level or flow gauge. In most observations of this character, the hydraulic slope has been assumed as parallel to the invert of the sewer, and a coefficient of roughness, *n* in Kutter's formula, has been assumed. In many cases these assumptions have probably been wide of the truth.

With regard to the hydraulic grade, the following comments by W. W. Horner, principal assistant engineer, Sewer Department, St. Louis, in a discussion of a paper by S. A. Greeley, in "Journal of the Western Society of Engineers" for September, 1913, are pertinent:

". . . It has been noted that there are marked differences between the grade of the sewer and the water surface grade. For example, in a 9-ft. sewer for one rain a depth of flow, at one point, of 4½ ft. was observed; 1,000 ft. downstream the depth was less than 4 ft. though several tributaries entered between, while 500 ft. farther downstream, the depth was over 5 ft. Similar variations have been noted in other rains. The sewer is uniform as to grade, size and condition. The most reasonable explanation of these differences is that the flow at the upper and lower gauges is distributed, in the case of the upper gauge, by a curve 200 ft. upstream, and of the lower by a 3-ft. lateral, discharging into the main sewer nearly at right angles, 100 ft. above the gauge. In both cases the velocities would be materially reduced from that computed by Kutter's formula. In another case, a sharp reverse curve and small local obstruction has been found to create a back pressure above of over 10 ft., although the sewer below was only slightly overcharged."

Other observers have had similar experiences. It is, therefore, evident that the use of the grade of the sewer as representing the hydraulic grade may result in serious errors in computing the actual flow in the sewer. It is obvious that correctly to compute this slope two or more water level indicators are necessary, and these must be exactly synchronized so that the true hydraulic slope corresponding to the depth at any time can be properly computed. The use of maximum flow gauges, indicating merely the maximum height reached by the flood wave at any point, for the purpose of determining the hydraulic slope, is not to be commended, although such gauges serve as a valuable check upon the readings of the automatic gauges. The crest of the flood wave progressing

downstream leaves its record on each of these gauges, but it is obvious that the hydraulic slope is not the slope between the highest point reached at one gauge and the highest point reached at the succeeding gauge, since the crest of the flood was not at both of these points at the same time.

Wide errors may also be introduced into the estimate of flow by incorrect assumption of the value of the coefficient. It is only necessary to call attention to the fact that the values of n in Kutter's formula for the classes of sewers ordinarily gauged may range from 0.009 to 0.017 in order to realize that assumptions of this coefficient may be far from the truth. These two values, as it happens, have been found by velocity measurements at Pawtucket and Philadelphia to apply to the particular cases referred to; but it is evident that the assumption of such coefficients without experimental determination may introduce serious errors, possibly as much as 50 per cent. Obviously, this method of estimating flow can only be correctly employed when the coefficient is experimentally determined for the sewer under consideration. Either the coefficient of roughness n in Kutter's formula, or the coefficient C in the Hazen-Williams formula, may be determined and employed in the estimation of flow. It is not thought best to use the Chezy formula directly, since the coefficient in this formula would not be constant for varying depths in the sewer and the resulting changes in the hydraulic radius.

In the study of run-off at Pawtucket the following investigations were made in an endeavor to find the value for n in the Kutter formula for the sewer under investigation. The diameter of the sewer was too small to permit of the use of current meters when measuring storm flows. It is seldom that a depth greater than one foot is reached in this sewer, and most of the observations had to do with much lesser depths.

Because of these conditions, floats were tried between manholes 447 ft. apart. The surface slope of the discharge corresponded with the slope of the sewer, as nearly as it was practical to measure the depth of flow, and the slope of the sewer, .006, was therefore adopted for the value of s.

The floats used were pieces of wood three inches in diameter and two inches long, and the time taken for the passage of these between manholes was recorded by observers. About 170 observations were recorded, during storms occurring between February, 1905, and February, 1906, and from these data ninety-one velocities were figured for various depths of flow between 0.16 and 1.1 ft. These velocities have been plotted and a curve drawn which corresponds very closely to the curve of Kutter's formula when using a value for n of .0085.

As the velocity measured was the surface velocity, and therefore, for the shallow depths observed, was very nearly a maximum, it is fair to assume a somewhat lower figure for the average velocity. Mr. Fteley, in his measurements of the flow in the Sudbury River Conduit, found the average velocity there to be about 88 per cent. of the maximum velocity, and a velocity curve cd, representing 88 per cent. of the observed velocity has been drawn.

This curve lies between the curves of the Kutter formula drawn with values for n of .010 and .009, but very close to the former curve. It is identical with the velocity curve of the Hazen and Williams formula when giving a value of 150 to c in that formula, [illegible] $0.001^{-0.04}$.

With respect to this latter formula, it may be said that c has a range of 145 to 152 when compared with the experiments of Darcy and Bazin in semi-circular conduits of 4.1 ft. diameter, with a surface of pure cement.

The following quotation is taken from W. G. Taylor's description of a new main intercepting sewer at Waterbury, Conn.: "Observations upon the sewage flow in the main carrier, at depths up to the springing line, have shown that the value of n in Kutter's formula when applied to the sewer flow is not greater than 0.010." The sewer for which these values were obtained was of reinforced concrete of horseshoe shape, 5 ft. 6 in. x 4 ft. 5 in. Great care was used in churning the deposited concrete, and the interior and exterior surfaces are reported as being "very smooth."

Types of Recording Gauges.—Leaving Venturi and current meters out of consideration, practically the only type of automatic gauge applicable to gauging storm water flows in sewers is a gauge of the water level recorder type. All of the gauges available for this purpose may be divided into two general classes—float gauges and pneumatic pressure gauges. Either class is equally applicable to keeping a continuous record of the head of water over a weir in case it is practicable to use a weir for accurate measurements of flow.

In order to secure proper registration with any type of gauge, it is practically essential to install the float or pressure chamber in a separate manhole connected with the sewer, rather than in the sewer itself. This adds materially to the cost of installing the gauge and keeping records of sewer flow, but it has not been found practicable to obtain trustworthy records by means of a gauge installed directly in the sewer itself.

In the float gauge a float contained within a pipe or other suitable guide is connected with a recording apparatus through the medium of a cord, chain, tape or by a solid rod or tube.

The report then presents descriptions of various recording gauges including the Hydro-Chronograph, Freiz's improved water stage register, Builders' iron water level register, pneumatic pressure and diaphragm gauges, and Sandborn's flow recorder.

Installation of Automatic Sewer Gauge.—A reliable automatic record of the depth of the storm flow in the sewer is of equal importance with the record of the rate of precipitation, but is even more difficult to obtain. So many difficulties beset the installation of an accessible recording device that it has been very hard to obtain the co-operation of municipal engineers in this work. In sewers less than four feet in diameter and in any sewer where the normal dry-weather flow is of very shallow depth, the installation of a recording device in the sewer itself is apt to produce such an obstruction to the flow as will set up artificial conditions, which make a record of the correct depth of flow impossible.

It is therefore much better to construct an auxiliary manhole, independent of the sewer, for the special purpose of installing the recording mechanism. In this manhole a float chamber can be constructed and connected with the main sewer by a small pipe, or pipes, and these need be the only connection with the sewer. Under such a construction it will be possible to visit and inspect the recording mechanism without the inconvenience attendant upon a descent into a regular manhole which is a part of the sewer itself. It will still have the disagreeable feature, however, of being below ground and accessible only through an opening in the street surface. A much better location for the recording device is at the edge of the curb and above the level of the sidewalk. This can be accomplished through a construction similar to a police

signal box, and the chart will thus be made readily accessible. The only criticism of such a method of installation lies in the necessity of providing some method of accurately checking the chart record with the depth of flow.

Particular care should be taken in connecting the gauging chamber or float chamber with the sewer, to see that the connecting pipe is normal to the direction of flow, and does not project into the sewer. If this precaution is not observed, the recorded heights will be in error—too high if the connecting pipe is directed upstream or against the current, and too low if in the reverse direction. The precautions taken should be the same as in installing a piezometer connection to a water pipe.

It is highly necessary that recording devices be regularly inspected in order that they may be sure to be in operation when most needed, and the more accessible and convenient it is possible to make their location, the more careful attention will they receive. Maximum rates of precipitation and the attendant depth of flow in the sewer are of infrequent occurrence, and it is very essential that the recording device be in operation whenever such a discharge takes place.

Maximum Flow Gauges.—Practically the only information to be obtained from a maximum flow gauge is the greatest height reached by the flood wave at the point of observation since the last recorded measurement. Ordinarily the records thus obtained are of little value, but they may occasionally serve as a valuable check upon the records of an automatic gauge which may be out of order and fail to indicate the highest point reached by the flood. It is, therefore, advisable to install such maximum flow gauges at all points where automatic water level recorders are installed.

In the earlier observations of run-off in sewers, the maximum gauges consisted merely of whitewashed laths set firmly in position in manholes, the expectation being that the highest point reached by the sewage would be clearly indicated on the whitewash. In some cases this simple type of gauge has proven satisfactory, although in many cases the whitewash has peeled off about the height to which the sewage reached, and in other cases, for some unexplained reason, the maximum height could not be distinguished upon the gauge. The most satisfactory type thus far devised consists of a rod to which are firmly fastened a number of small vials having their mouths set at uniform distances apart, usually one-tenth or two-tenths of a foot, the whole being properly protected from the flowing current by a shield or perforated tube. On examining this rod, it is evident that the sewage must have been as high as the highest vial which is found to be filled with water. Inverting the rod and emptying the vials is all that is necessary to prepare the gauge for use. This type of gauge is best located in a manhole, with the bottom of the gauge slightly above the normal dry-weather flow. In some cases, gauges of this type have not proved satisfactory where high velocities have obtained—such as 8 ft. per second.

Actual Measurements of Storm-water Flow.—The report contains, in tabular form, all available records of storm-water flows in sewers, including not only those which have been made in co-operation with the committee and submitted to it for publication, but all other published records of storm sewer gaugings which have come to its attention. It gives also a detailed description of apparatus and methods used in a study of rainfall and run-off at Pawtucket, R.I.

Rate of Precipitation Causing Maximum Flow.—It is of the greatest importance in arriving at a correct conclusion that the maximum rate of flow in the sewer be compared with the rainfall which actually caused this run-off. It is, therefore, particularly important that the time required for concentration of run-off at the gauging point, under the conditions existing at the time when the gauging was made, be accurately known.

It is evident that if the time required for the concentration of the run-off at the gauging point is thirty minutes, the run-off factor obtained by comparing the maximum rate of run-off with the rate of rainfall which obtained for a period of five minutes, or with the average rate which obtained for a period of sixty minutes, would be considerably in error, unless the rate were uniform in the latter case. In such comparisons it is evident that the actual time of concentration existing for the particular gauging is the figure desired—not the computed time of concentration for maximum velocities of flow, which may be widely different from those existing. If the sewers are but partly filled and the velocity of flow is less than the maximum velocity, it is evident that the time of concentration will be considerably greater than the time computed upon the basis of maximum velocities.

Another point requiring careful consideration is the interpretation of the run-off from storms of less total duration, or having a downpour of less total duration, than the time of concentration for the drainage system gauged. This is particularly true in the case of large areas for which the time of concentration is considerable. It is not often that storms occur of sufficient uniform intensity to produce a noticeable "flood wave," and lasting from thirty to sixty or ninety minutes. Accordingly, storms which give significant information relating to drainage areas for which the time of concentration exceeds thirty minutes are of rare occurrence, and records of value for such systems are obtainable only after a number of years of observation. Much valuable information could be obtained in shorter periods of time if sub-districts, for which the time of concentration would be short, were gauged. The committee spent a large amount of time in endeavoring to obtain significant information from storms in which the period of downpour was of less duration than the time of concentration of the district gauged, but had been forced to the conclusion that, with present knowledge, no information of value can be obtained from such records. It seems impossible to estimate the area actually yielding storm water from a shower of less duration than the time of concentration. Take, for instance, the case of a heavy downpour lasting ten minutes upon a drainage area for which the time of concentration is thirty minutes. If the entire rainstorm lasts but ten minutes, it is evident that the maximum rate of run-off represents the discharge from but a portion of the drainage area. Whether this is the portion lying nearest the outlet or some other part of the drainage area, it would be impossible to tell without a very large amount of information. If the storm included a heavy downpour of ten minutes' duration, followed by a drizzle of indefinite duration, the maximum run-off would probably occur when a section of the drainage area at a distance from the gauging point was contributing at the maximum rate, while portions nearer the gauging point were contributing the run-off corresponding to the lighter rainfall which followed the downpour. It is therefore impossible to say what the true contributing drainage area to the maximum run-off amounted to, or what is the proper rate of precipitation with which that run-off should be compared.

The report concluded with a description of the sewer districts gauged, together with data relating to the location and type of rain gauge, method of gauging flow, etc.

The committee expressed itself of the opinion that more will be accomplished by a larger number of gaugings of small drainage areas than by attempts to gauge areas of larger extent. With the smaller drainage areas the time of concentration will be less and there will be a much larger number of storms in which there can be little doubt that the maximum rate of rainfall continued at a uniform rate for a sufficient period to produce the maximum observed run-off, and accordingly, the resulting computed coefficient of run-off will be more nearly correct. In such cases, also, the difference between the computed time of concentration under conditions of maximum velocity through the sewer, and the time of concentration actually existing for any particular observation, will be slight. Moreover, in small districts, the main channels will not be large and the effect upon the results of storage in the sewers themselves will not be great.

It is not intended to minimize the value of careful gaugings of the medium-sized and larger drainage areas. Such measurements are of great value and it is to be hoped that they will be continued. Measurements of discharge from areas of 200 to 500 acres are perhaps likely to be of most general applicability, and should be encouraged whenever it is possible to make an extended series of gaugings. Where, however, the means are seriously limited and the probability of continuing gaugings over a long period is not great, it is believed wiser to carry out measurements upon smaller districts from which results can be obtained in a shorter period of time. It is very much to be desired that measurements of the flow from subdistricts, which together make up a large district, whether or not the entire district is also gauged as a whole, should be undertaken as extensively as possible.

Information relating to inlet time or time required from the beginning of the rain to the moment when the flow is established at the storm water inlet is also of importance, and little or no accurate information is to be had upon this subject.

The personnel of the committee was as follows: George A. Carpenter, chairman; Harrison P. Eddy, secretary; William S. Johnson, Hector J. Hughes, Lewis M. Hastings, Arthur T. Safford, George C. Whipple, Harold K. Barrows.

MONTREAL IRON AND STEEL SITUATION.

In iron and steel circles it is declared that the foundries are not working more than 10 per cent. to 20 per cent. as many hours as they worked formerly. The larger industries, such as the railway shops, car and locomotive works, are almost closed down. The repair shops of one sort and another seem to be about half occupied, and foundries engaged on staple lines—such, for instance, as stoves, furnaces, etc., are apparently working about 75 per cent. of capacity. On the whole, the demand for iron has fallen off to a minimum.

The trade is keeping a close watch on developments on the other side of the line where the steel companies seem to have been meeting a rather better demand lately, and where the orders placed show a considerable increase in volume, although it is understood that this increase was largely the result of a shading in price in the Pittsburg district. Around Buffalo, prices appear to be holding firm.

The opinion in the trade is that little or no improvement is in sight. The only consolation is that consumption is undoubtedly greater than production, and the result must sooner or later be that new supplies will have to be purchased.

Montreal, June 23rd, 1914.

OIL PRODUCTION IN CANADA.

In view of the publicity given to the oil area in the vicinity of Calgary, and the numerous companies formed since the discovery, a partial list of which has been given in recent issues of *The Canadian Engineer*, the following government return is especially interesting.

The production of crude petroleum in Canada was still confined during 1913 to the old established fields in Ontario with a few barrels pumped from gas wells in New Brunswick.

The annual output has been steadily declining during the past six years, and shows a further falling off in quantity produced in 1913, although owing to the higher price obtained for oil a larger total value is shown than for 1912.

A bounty of one and a half cents per imperial gallon is paid upon the production of crude petroleum, the Bounty Act being administered and payments made by the department of trade and commerce. According to the records of this department the total output of petroleum in 1913 was 228,080 barrels or 7,982,798 gallons on which a bounty of $119,741.97 was paid. The total value of the production at the average price for the year $1.782 per barrel was $406,439.

The production in 1912 was 243,336 barrels or 8,516,762 gallons valued at $345,050, or an average value of $1.418 per barrel. The average price per barrel at Petrolia during 1913 increased from a minimum on January 1 of $1.65 to $1.75 on April 16, $1.84 November 6, and $1.89 on December 22.

The production in Ontario as furnished by the supervisor of petroleum bounties was in 1913 as follows in barrels:—Lambton, 155,747; Tilbury, 26,824; Bothwell, 34,349; Dutton, 4,610; Onondaga, 4,172, and Belle River, 464, or a total of 226,166 barrels. In 1912 the production by districts was: Lambton, 150,272; Tilbury, 44,727; Bothwell, 34,486; Dutton, 4,335, and Onondaga, 7,115, or a total of 240,935 barrels.

The production in New Brunswick in 1913 was 2,111 barrels as against 2,679 barrels in 1912 and 2,461 barrels in 1911.

Exports entered as crude mineral oil in 1913 were 3,650 gallons valued at $379 and refined oil 24,273 gallons valued at $3,188. There was also an export of naphtha and gasoline of 17,875 gallons valued at $4,284.

The total value of the imports of petroleum and petroleum products in 1913, states Mr. J. McLeish, in his annual report, amounted to $13,339,326 as against a value of $11,978,053 in 1912. The imports have been increasing rapidly during the past few years.

Crude oil is being extensively used as fuel on the Pacific Coast in both steamships and locomotives, and the wide use of the gasoline motor has created a big demand for gasoline. The total imports of petroleum oils, crude and refined, in 1913 were 222,779,293 gallons, valued at $13,230,429 in addition to 1,628,837 pounds of wax and candles valued at $108,897. The oil imports included crude oil 162,062,201 gallons, valued at $5,250,835; refined and illuminating oils 19,393,627 gallons valued at $1,386,440; gasoline 29,525,170 gallons valued at $4,822,941; lubricating oils 6,789,451 gallons valued at $1,172,986, and other petroleum products 5,008,844 gallons valued at $507,227.

The total imports in 1912 were 186,787,484 gallons of petroleum oils crude and refined valued at $11,858,533 in addition to 2,144,006 pounds of paraffin wax and candles valued at $119,520. The oil imports included: crude oil, 120,082,405 gallons, valued at $3,996,842; refined and illuminating oils, 14,748,218 gallons valued at $1,012,735; gasoline, 40,904,598 gallons valued at $5,347,767; lubricating oils, 6,763,800 gallons valued at $1,077,712, and other petroleum products 4,288,463 gallons valued at $423,477.

There was an increased importation in 1913 of all classes of oil with the exception of gasoline, the increases being most pronounced in crude oil and refined illuminating oil.

There was comparatively little change in the production of natural gas in Ontario, but a large increase in the production in New Brunswick and in Alberta. The total production in 1913 was approximately 20,345 million feet valued at $3,338,314, of which 828 million feet valued at $174,006 was from New Brunswick; 12,487 million feet valued at $2,092,400 from Ontario and 7,030 million feet valued at $1,071,908 from Alberta.

The production in 1912 was reported as 15,287 million feet valued at $2,362,700, and included 174 million feet from New Brunswick valued at $36,540; 12,529 million feet from Ontario valued at $2,036,245 and 2,584 million feet from Alberta valued at $289,906.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

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BOOK REVIEWS.

Poor's Manual of Public Utilities for 1914.—Published by Poor's Railroad Manual Company, 535 Pearl Street, New York. Second Annual Number. 2172 pages of text; 6 x 9 ins.

This important financial reference work contains 248 pages more than the first edition. About 400 new statements and 300 new comparative tables have been added. Bond descriptions have been amplified, and in the majority of them information is given showing whether or not interest is payable without deduction for the normal United States income tax.

A valuable new feature is the re-arrangement of the street railways. The old arrangement of presenting statements by States has been dropped in order that street railways in public utility systems may appear in connection with the statements of the respective holding companies.

The manual is the only one devoted entirely to the public service corporations. It gives the same service to the public utilities that Poor's Manual of Railroads has given to the railroads for nearly half a century.

The Electric Furnace.—By Alfred Stansfield, D.Sc., Professor of Metallurgy, McGill University. Published by McGraw Hill Book Company, New York. 415 pages, 155 illustrations, 6 x 9 ins.; cloth. Price, $4.00. Reviewed by T. R. Loudon, Assistant Professor of Ferro-Metallurgy, University of Toronto.

This book is an enlargement of the well-known first edition, published in book form in 1907 after portions had appeared as serial articles in *The Canadian Engineer.*

As stated in the introduction, it has been the author's endeavor to trace the evolution of the electric furnace and to set forth the outstanding facts relative to the theory and practice in design and operation of the present-day furnace. The author is to be congratulated on the clearness with which this has been accomplished. The work is, of course, very largely a compilation of theory, the references being quite numerous and varied.

There are fifteen chapters as follows: History, Description and Classification of Electric Furnaces; Efficiency of Electric and other Furnaces and Relative Cost of Electrical and Fuel Heat; Construction and Design; Operation; Laboratory Furnace; Production of Pig Iron; Production of Steel from Metallic Ingredients; Production of Steel from Ore; Ferro Alloys; Graphite and Carbides; Zinc and other Metals; Miscellaneous Uses; Electrolysis and Electrolytic Processes; Future Developments. The above list is abbreviated in some cases.

Chapter IV. on Construction and Design gives a good description of the various refractories used in furnace construction. The description is necessarily brief, but is well written, which is not always the case in most descriptions of refractories. A number of details of construction are given, but in this respect there is rather a lack, the discussion having the appearance of being too theoretical.

The chapter on Operation has also the objection of being theoretical. The term "operation" obviously refers to the practical. Such sections as voltages required for electric furnaces and current density in furnaces would be more in keeping in the chapter on Design.

Chapter VII. deals with the production of pig iron.

A great deal of space is taken up in discussing the results obtained in the Sault Ste. Marie experiments and the European Commission's report. The familiar results of the Swedish furnaces and the furnaces at Herault, California, are also given.

Chapter VIII., dealing with the various forms of steel furnaces, gives descriptions of the well-known types. Chapter IX. discusses the making of steel from iron ore, dwelling at length on experiments carried on by the author himself in the so-called Evans Stansfield furnace. It is worthy of note that the only practical furnace in Canada has been omitted; that is, the Moffatt-Irving furnace, which has been in operation for some time making steel from ore.

The author has gone very thoroughly into the question of zinc smelting.

The book is a valuable compendium of references on articles scattered throughout the technical literature of the day.

Designing and Detailing of Simple Steel Structures.—By Clyde T. Morris, C.E., Professor of Structural Engineering, Ohio State University. Published by McGraw-Hill Book Company, Inc., New York City. Third edition; 260 pages; 94 illustrations; cloth; 6 x 9 ins. Price, $2.25.

This book has been carefully revised and reset, portions of it having been practically re-written since the publication of the first edition in 1909. Those who are familiar with the previous works will note a change in the order of the chapters and an increase in volume. The chapters, as they occur, are as follows: Designing and Estimating; Riveting; Mill Buildings; Plate Girder Bridges; Pin-connected Bridges; Highway Bridges, Manufacture; and an appendix containing the general specifications for steel railway bridges (1911) of Ohio State Highway Department.

The book will be found valuable as an elementary treatise upon design, and students in engineering colleges and technical schools have in it a work adapted to their needs and to the limited time which they generally have in which to refer to the subject. The text contains numerical examples which add materially to the descriptive matter and the carefully-arranged exposition of theory.

The Coöperation of Science and Industry.—By S. Roy Illingworth. Published by Chas. Griffin & Company, Limited, Strand, London, England. 91 pages; 3½ x 5 ins.; leather. Price, 30 cents net.

In this little work Mr. Illingworth has urged a closer relation between industrial establishments and applied science. The problem has been viewed from an impartial standpoint, commencing with the long and tedious period prior to the 18th century, through which the gradual evolution of industrial enterprises experienced comparatively unappreciable change compared with the momentum which the same and similar industries have gained since the development of industrial research in the 18th century. The author refers to the work of the scientist in the cultivation of the by-products of coal as an example of what may be accomplished when applied science is permitted to unite with industry in the promotion of efficiency and of new commercial enterprises.

The Englishman, regarded as the pioneer of industry, is pronounced delinquent and too prone to disregard processes as unremunerative or useless rather than to recognize the value of the application of science thereto. The present industrial position of Germany is presented as an example of the results which might be expected from a judicious intermingling of the two.

Taken altogether, the book presents some forceful arguments in favor of more scientific methods in the establishments of the British manufacturer, and its application should not be considered limited to any country or to any industry.

Engineering Manual.—Published by the American Electric Railway Engineering Association, New York City. Size, 6 x 9 ins.; cloth binder. Price, $3.00; binders, $1.00.

This Engineering Manual for 1914 is a compilation of the standards and recommendations adopted by the Association, and covers practically the entire field of electric engineering. Miscellaneous methods and practices are outlined therein which include, as well, all definitely approved recommendations other than those of the Association itself. It is in the form of a loose-leaf binder, and includes 82 sections, which are fully illustrated with diagrams and working drawings. The Manual, which is free to members of the Association, has been put into loose-leaf form in order that the standards and recommendations may keep pace with such additions and alterations as are made at the yearly conventions of the associations.

The volume possesses a very complete index of the material contained therein, and covers also references to related subjects as to their location in the proceedings of the Association. Being revised each year and containing a complete collection of information of the most practical value to electric railway men, the volume will be found of great use.

The Job, The Man, The Boss.—By Dr. K. H. M. Blackford and Arthur Newcomb. Published by Doubleday, Page & Company, New York, 1914. 226 pages, 23 half-tone illustrations. Price, $1.60. Reviewed by Geo. S. Hodgins, Assistant Engineer (Mechanical Department), National Transcontinental Railway.

In a quite remarkable book dealing with the engaging or hiring of men, the authors show that each man bears about with him in his speech, behavior and actions the indelible record of his tastes, faculties and aptitudes. It is the business of the Employment Bureau, wherever established, in factory, mill, bank or railway repair shop, to view with the trained eye of science each applicant for work; and with what amounts to almost complete knowledge of his past, revealed by his build, his words, his movements and his health, to predict his future actions, and to "fit" him in his place.

With this kind of knowledge, and knowing the requirements of each job, the employment department picks out the best available man and places him where he ought to be, and where he will find his work congenial. Here he will do his best work and please himself and be a source of profit and satisfaction to his employer.

The book is not only a valuable contribution to the whole science of selecting men, but is a practical work that well might be in the hands of any intelligent foreman or gang-boss who handles applicants where the "hire-and-fire" system still prevails. A railway roundhouse, a small machine shop, or even a special laborers' squad, would feel the benefits of the system here outlined.

It is pleasant reading, easily understood, and the matter, once taken in, sticks in the mind for ready reference and for use. The chapters on "Analyzing the Man," beginning with "heredity and environment," are simply fascinating. The "nine physical variables" are defined and explained, how they came into being, what they mean, what they still stand for, and why they are evidence of character and aptitude. This kind of knowledge may easily prevent a boss from shoving a square peg into a round hole

All men bear about in face and frame and gait and word, certain evidences of character. They cannot conceal them if they would, and the majority do not know they have them, but they betray their likes and prejudices, their aptitudes and abilities, in many curious ways, like Achilles, concealed among the daughters of Lycomodes, who, unthinking, stretched forth his hand to grasp the sword as it clanged down upon the floor from amid the costly fabrics, and thus revealed himself to the astute Ulysses, who had brought the gorgeous raiment, ostensibly to charm the maidens, and to gain their father's smile.

The book is written in a kindly, optimistic spirit that looks for the dawn of a brighter day for all. There is no trace of idle dreaming; it is the clear and helpful statement of undoubted scientific fact.

A Treatise on the Inspection of Concrete Construction.—By Jerome Cochran, B.S., C.E., M.C.E. Published by Myron C. Clark Publishing Company, Chicago. 595 pages; 26 illustrations; 6 x 9 ins.; cloth. Price, $4.00. Reviewed by C. S. L. Hertzberg, of James, Loudon and Hertzberg, Consulting Engineers, Toronto.

This book is a very elaborate and comprehensive treatise on all phases of concrete work. It is intended, primarily, for the use of inspectors on concrete construction, but it is a work which will be found very useful to engineers, architects, contractors, and, in fact, anyone who is in any way interested in concrete work.

The introduction deals, at some length, with the necessity of good inspection, and outlines, in a brief way, the duties, necessary qualifications and responsibilities of the inspector, together with a few hints as to the best way of dealing with contractors, etc.

A rather complete treatise on cement and aggregates is given in Chapters I. and II., together with methods of testing and standard requirements.

Chapters III. and IV. deal with the inspection of mixing operations and form work.

In Chapters V., VI. and VII. the inspection of reinforcing steel, pouring of concrete and concrete finishes are fully treated. The remainder of the book deals, in detail, with the inspection of particular types of concrete construction.

It is seldom one meets with a book so thorough in its attention to important details, and the author's complete familiarity with concrete construction in all its numerous forms has resulted in the production of a particularly useful book.

In the chapter on the proportioning of concrete a 1:2:4 mix is referred to (when speaking of the aggregate collectively) as a 1:6 mix. The meaning is made quite clear in the sentence which follows, and there should be no reason for any misinterpretation. However, this method of referring to proportions has led to errors being made when the aggregate was composed of unscreened, pit-run gravel, and a mixture of one of cement to six of gravel has been substituted for the specified 1:2:4 mix. A number of engineers are now referring to the combined aggregate equivalent of a 1:2:4 concrete as a 1:4 concrete.

Engineering Geology.—By Heinrich Ries, Ph.D., and Thos. L. Watson, Professors of Economic Geology in Cornell and Virginia Universities, respectively. Published by John Wiley and Sons, New York (Canadian Selling Agents, Renouf Publishing Company, Montreal). 672 + 26 pages; 400 illustrations; cloth; 6 x 9 ins. Price, $4.00 net. Reviewed by J. Keele, Geological Survey of Canada.

It has long been the opinion of those who have given consideration to the subject, that a course in applied geology is better suited to the needs of students in engineering than a portion of the abstract course in this science for arts students which they usually receive. The limited time at the disposal of the engineering student does not allow of going very far into the study of general geology; hence, as a rule, he is not very much interested in it, and promptly forgets the little he learns at college. It would seem, therefore, that the application of the principles of geology to the problems of engineering might be the best method of securing his attention.

This is the object of Messrs. Ries and Watson in their book, entitled "Engineering Geology." The authors are geologists of wide experience, both in teaching and field work, and, moreover, have given special attention to the part geology has played in all modern engineering achievement. Therefore, they are well qualified to select and put in order those aspects of geology that some time or other will surely enter into the practice of general engineering. Beginning with the common rock-forming minerals which leads to rocks in general and a description of their structural features, we have in the first three chapters as much as any engineer wants to know on these subjects. The importance of certain structural features, such as faulting and folding, with their influence on tunnels, aqueducts or foundations, are emphasized in separate sections. Defects in the earth's crust sometimes have a disagreeable manner of asserting themselves to the unwary engineer.

Four chapters are devoted to the work of water, both above and below the surface of the earth. The relation of wave action and shore currents to coasts and harbors, the destructive and constructive work of stream erosion, the effect of superficial deposits and bed-rock structure upon underground water, and the conditions that lead to pollution of water supply are all very fully explained and illustrated by sections and diagrams. The manner in which the subject of the work of water is presented deserves attention. Physiography is that branch of geology which deals with land forms and the causes, mainly erosional, that produce them. It may be reckoned as a purely cultural subject, like Greek, when regarded from the theoretic point of view. The authors of "Engineering Geology" dispense with an intricate discussion on the genesis of land forms, but by practical applications of the results of the forces at work indicate how these forms were produced.

An important part of the work of modern engineering is concerned with controlling, distributing, and conserving water supplies. Enormous sums of money are spent on these undertakings. Therefore, a thorough knowledge of all the influences that may affect these undertakings is an essential portion of an engineer's equipment.

Although rocks, clays and soils enter largely into the industrial life, and social welfare of our country, intimate knowledge of these materials is rare, and important problems regarding their utilization are still unsolved. The chapter on rock weathering and formation of soils in this volume forms an introduction to the relation between geology and structural materials. These include building stone, limes, cements, plaster, clays and clay products. In addition to a brief account of occurrence of these materials in nature, a surprisingly large amount of the technology of them is condensed within a small compass.

The coal series, petroleum and natural gas, are very fully treated in the space allotted to them. A chapter on the origin, nature and occurrence of the principal metallic ore deposits concludes the volume.

Although this book is written mainly for the use of civil engineers, mining engineers will also find much useful matter in it. It is essentially a work on geology for the technical man.

A list of works of reference at the end of each chapter is a valuable feature of the book. It is also very fully illustrated with half-tone reproductions of photographs, and numerous line drawings of an explanatory nature.

Foundations of Bridges and Buildings.—By Henry S. Jacoby, Professor of Bridge Engineering, Cornell University, and Roland P. Davis, Professor of Structural and Hydraulic Engineering, West Virginia University. New York: McGraw-Hill Book Company, Inc. Cloth; xvi. + 603 pages; 295 text figures and full-page illustrations; 6 x 9 ins. Price, $5.00 net. Reviewed by C. R. Young, C.E., Assistant Professor of Structural Engineering, University of Toronto.

Heretofore the engineer or student who found occasion to consult the literature of foundations was unable to turn to any comprehensive modern treatise on the subject. It is true that books in English on foundations have been available for some time, but none which could truly be said to cover the field fully, logically and in a manner suited to the needs both of the engineer and of the engineer-to-be. Professors Jacoby and Davis have admirably supplied this need in the present volume.

A cursory examination of the book is sufficient to impress the reader with the vast amount of labor involved in assembling and compressing within 600 odd pages the information presented to him. Perhaps there will be some who would wish that their own special methods or contrivances had received fuller consideration, but it is difficult to see how this could be done without disturbing the admirable balance preserved by the authors throughout.

A feature indicating the authoritative character of the book, if anything further than the standing of the authors themselves were needed, is the inclusion of a chapter on "Pneumatic Caisson Practice" by the well-known expert on deep foundations, T. Kennard Thomson, C.E., D.Sc., Consulting Engineer, of New York City.

Of the nineteen chapters, the first five are devoted to the subject of bearing and sheet piles. This is justified by the authors on the ground that young engineers are more likely to obtain their early experience with pile foundations than with any other class of foundation construction. Special

effort has been made to present the subject-matter relating to piles so as to meet the requirements of students without experience. Chapter I. is devoted to Timber Piles and Drivers, Chapter II. to Driving Timber Piles, and Chapter III. to Bearing Power of Piles. In describing the use of the water jet, no mention is made of a practice that has found favor in Canada, viz., loosening up the material into which the piles are to be driven by a water jet and then, after the jet is withdrawn, driving the pile before the material has had a chance to settle down firmly again. Concrete piles, treated in Chapter IV., receive special consideration in the matter of driving and bearing power, apart from the general discussion of these subjects in Chapters II. and III. Metal and Sheet piles are covered in Chapter V.

In Chapters VI. to XI., inclusive, the various constructions and methods adopted for placing foundations under water are given detailed treatment. The subjects considered are: Cofferdams, Box and Open Caissons, Pneumatic Caissons for Bridges, Pneumatic Caissons for Buildings and Pier Foundations in Open Wells.

Three chapters on piers and abutments are incorporated in the work for the reason that courses in masonry construction and foundations are frequently combined in engineering colleges.

An excellent chapter on spread foundations is included, numerical examples, both in steel grillages and reinforced concrete footings being worked out. In the footnote to Table 153 a, on page 461, the pressure on the earth in pounds per square foot is erroneously stated to be due to "dead, live, and dead plus live load." Reference to the table itself shows that this should be "dead, dead plus ½ live load and dead plus live load."

Two useful chapters are those on Underpinning Buildings and Explorations and Unit Loads. Logical, up-to-date treatments of these subjects in text-books have up to the present been lacking.

Chapter XVIII., by Dr. T. Kennard Thomson, concludes the text proper.

One of the most valuable features of the book is the extensive list of references to engineering literature contained in Chapter XIX. From this the student or engineer can carry his investigation of the subject to the limit of detail desired.

It is a pleasure to turn over the pages of a book exhibiting the evidences of authority and care in presentation characterizing the present volume. No engineer having to do with foundations can afford to be without a copy, and perhaps when the full merit of the work is realized none will care to undertake an unfamiliar piece of work without consulting it.

Modern Business.—Edited by Joseph French Johnson, Dean, New York University School of Commerce, Accounts and Finance. Published by the Alexander Hamilton Institute, New York. Canadian office, C.P.R. Building, Toronto.

This is a series of eighteen treatises, published in twelve volumes, forming the basis of a modern business course and service. While it does not touch upon engineering in all its departments, there are many sections from which the engineer may derive much instruction and benefit, as will be recognized from the following synopsis of the subjects included:—

Volume I., Applied Economics, by James Mavor, Professor of Political Economy, University of Toronto; Volume II., Organization and Management, by Lee Galloway, of New York University; Volume III., Selling, by Ralph Starr Butler, of University of Wisconsin; Credits, by Lee Galloway, of New York University, revised by W. W. Swanson, of Queen's University, Kingston; Traffic, by Hon. S. J. McLean, Member of Board of Railway Commissioners for Canada; Volume IV., Advertising, by Lee Galloway, of New York University; Correspondence, by George B. Hotchkiss, of New York University; Volume V., Accounting Practice, by Leo Greendlinger, of New York University, revised by E. W. Wright, of the Toronto Bar; Volume VI., Corporation Finance, by W. H. Lough, formerly of New York University, revised by Fred. W. Field, Managing Editor, *Monetary Times*, Toronto; Volume VII., Money and Banking, by Joseph French Johnson, of New York University, and Earl Dean Howard, of Northwestern University; Volume VIII., Banking Practice, by E. L. Stewart-Patterson, of the Canadian Bank of Commerce; Foreign Exchange, by Franklin Escher, Editor of "Investments," New York City, revised by E. L. Stewart-Patterson, of the Canadian Bank of Commerce; Volume IX., Investment and Speculation, by Thomas Conway, Jr., of University of Pennsylvania, revised by Fred. W. Field; Volume X., Insurance, by Edward R. Hardy, of the New York Fire Insurance Exchange, revised by Fred. W. Field; Real Estate, by Walter Linder, of the Title Guarantee and Trust Company, of New York City, revised by E. W. Wright, of the Toronto Bar; Volume XI., Auditing, by Seymour Walton, C.P.A., of Chicago, revised by E. W. Wright, of the Toronto Bar; Cost Accounts, by Stephen W. Gilman, of University of Wisconsin: Volume XII., Commercial Law, by W. S. Johnson, of the Montreal Bar.

The series as a whole is a complete and logical digest of the principles and practices of present-day business, and is a most valuable contribution to business literature. It has been entirely re-written for Canadian use, and should prove an important factor in improving business methods. Four of the treatises, those dealing with the conditions that are quite different in Canada from what they are in the United States, are entirely new. We refer to the treatises on applied economics, railway traffic, banking practice and commercial law. In the first, Professor Mavor, so well known among Canadian economists, has exhibited a wonderful knowledge of business conditions in Canada, and his work abounds in concrete information that is of great value to anyone interested in the economic problems of the country. It is as well a general introduction to the whole series, and touches upon almost all of the questions raised in the subsequent volumes. In the treatise on traffic Hon. J. S. McLean, of the Dominion Board of Railway Commissioners, has presented a complete and able discussion of the factors which govern freight rates in this country. The treatise is divided into 10 chapters devoted to the following phases of the subject: Canadian Transportation; Freight Classification; Freight Rates; Freight Rates in Practice; Phases of Rates and Tariff; Passenger Rates; Practical Phases of Railway Business; Express Service; Inland Water Transportation; Foreign Trade and Ocean Transportation. There has been so much partisan controversy in this field that it is a relief to find the subject treated with such marked impartiality. The work will undoubtedly be influential in bringing about a reasonable and mutually satisfactory agreement as to the traffic problems which exist.

Another volume that should prove of interest and value is devoted to "Organization and Management." This book, by Lee Galloway, the author of "Economics of Dock Management," has been pronounced the most comprehensive text on this subject that has so far appeared. At any rate, in the opinion of the reviewer, a knowledge of the principles which are set forth in this volume is a necessary part of the equipment of every present-day executive. It is on a subject, moreover, that is engaging the attention of progressive business men throughout the world.

There is a volume devoted to corporation finance which is an exposition of the principles and methods covering the promotion, organization and management of modern corporations. The information contained therein is largely

drawn from the experience of the big industrial and railroad companies, whose methods are well developed and worthy of study and imitation by the management of smaller corporations. The book on accounting practice is a comprehensive statement of accounting principles and methods illustrated by modern forms and problems. Chapters on capital and revenue, on depreciation and other reserves, render it a valuable book for the man in engineering and contracting from a business standpoint.

One often hears assertions respecting the value of the study of English in an engineering training. Engineers are frequently placed at a disadvantage, particularly young engineers, when called upon to make a report upon a certain problem, or a progress report as construction work goes on. Similarly, a lack of fluency in the expression of thought is to be found occasionally in an engineer's correspondence. Written expression of thought requires more care and consideration on the part of the writer than verbal expression, and those who have little writing to do are frequently at a loss to properly convey upon paper the intended meaning as they could readily do by word of mouth. One of the subjects which is given a careful study is in connection with correspondence. It takes up in a masterful way the art and its problems, the principles of construction and the essential points connected with letters of various kinds.

In the same volume is contained a treatise on advertising which the manufacturer and the salesman will find of exceeding value in his work.

In all, they should appeal strongly to mature business men who wish to supplement their practical experiences by getting into touch with the ideas and experiences of other successful business men, and to young men who are just getting well started in business, and who need, above everything else, to get a grasp on the principles which underlie modern business practice.

The whole series of texts is claimed by the publishers to be but a single feature of a complete modern business course and service which aims to make available for business men of Canada a fund of information that they cannot get out of their own experiences. The books have been well edited and bound in a durable flexible backing.

Steel Bridge Designing.—By Melville B. Wells, C.E., Associate Professor of Bridge and Structural Engineering, Armour Institute of Technology. Cloth; 6¼ x 9¼ ins.; 260 pages; 43 illustrations; 26 pages. Published by Myron C. Clark Publishing Company, Chicago. Price, $2.50 net.

This book is intended primarily for use in engineering colleges and also as a reference book in the drafting-rooms of bridge works. To the instructor, the student, and the man in the drawing office it can be well recommended.

The first three chapters treat the subject of bridge designing in a general way, Chap. 1 dealing with engineers' work and contracts; Chap. 2, bridge manufacture, and Chap. 3, rivets. The next six chapters relate to actual design, Chap. 4 containing the design of a 50-ft. roof truss, Chap. 5 discussing types and details of highway bridges, and so on, each chapter giving the detailed numerical computations of the example under consideration.

Chapter 11 has to do with shop drawings, their general considerations, arrangement, markings, dimensions, etc.

The subject of Strength of Materials is dealt with to the extent of 30 pages in Chap. 12. Sections of it are devoted to: centre of gravity, moment of inertia, radius of gyration, flexure and deflection of beams, shear, column formulas, latticing, combined stresses, pins and rollers, deflection of a truss, bending moment on plate girder webs, [illegible] gives briefly the derivations of the principal formulas used in bridge designing, with examples of their applications when such examples in other parts of the book are not referred to. With respect to its insertion, the author states: "The student is assumed to know the methods of calculating stresses, also to have studied the subject of strength of materials. In designing, however, it is often desirable to refer to a volume on mechanics or strength of materials. Such a volume is not always accessible, and the tendency is for students to fall into the dangerous practice of using formulas blindly, not knowing their derivations and correct applications."

Chap. 13 presents a bibliography of supplementary reading on the various subjects treated in the text, and should prove of great service to the reader. The closing chapter contains the general specifications for steel railway bridges adopted by the American Railway Engineering Association in 1910.

There are twenty-six folding plates of shop and general drawings, from which have been taken the examples used throughout the text. There are other good illustrations throughout the book, while its typography, press-work and binding are all very commendable.

PUBLICATIONS RECEIVED.

Annual Report of the International Harvester Corporation to December 31st, 1913.

Town of Oshawa, Auditor's Report for 1913.—Containing detailed statement, receipts and expenditures, assets and liabilities, and report of water commissioners.

Problems of the Petroleum Industry.—By Irving C. Allen, United States Department of Mines. Information derived from conferences at Pittsburg in 1913.

Wheaton District, Yukon Territory.—A 150-page bulletin listed as Memoir No. 31, Geological Survey Branch, Department of Mines, Canada. Prepared by D. D. Cairns.

Fires in Lake Superior Iron Mines.—By Edwin Higgins, of the United States Bureau of Mines. A 34-page illustrated pamphlet dealing with mine fires and their prevention.

Town Planning Act.—First draft of the Town Planning Act prepared by the Commission of Conservation, Canada, for discussion at the 6th annual conference on city planning.

International Conference of Mine-Experiment Stations.—Compiled by Geo. S. Rice as Bulletin No. 82, United States Bureau of Mines, concerning Pittsburg Conference, September, 1912.

Water Commissioners of London, Ont.—(35th Annual Report, 1913), of the city of London waterworks, electrical and parks department. H. J. Glaubitz, general manager. 124 pages; illustrated.

Mines Sign-Boards.—Technical paper No. 67, United States Bureau of Mines, dealing with the use of sign-boards in mines for various purposes and containing recommendations for universal symbols.

Efficient Use of Cars.—Booklet issued by the Westinghouse Electric and Manufacturing Company containing suggestions received from operating railway men on the efficient use of cars and cost of stops.

American Highway Association and American Automobile Association Proceedings of the 3rd American Road Congress, held in Detroit, September, 1913. 312 pages; [illegible] ins. Price, [illegible], postpaid.

Cedars Rapids Manufacturing and Power Company.—Third Progress Report (May, 1914), on the construction of the Cedars Rapids hydro-electric development on the St. Lawrence River. 28 pages; illustrated.

Climate of British Columbia. Tables of rain and snow fall and temperature; altitude of places, lakes and mountains. Second edition of Bulletin No. 27, Bureau of Provincial Information, British Columbia.

American Road Builders' Association.—Proceedings of the 10th annual convention, held at Philadelphia, December, 1913, including reports of executive committee, secretary-treasurer, etc. 320 pages; 6 x 9 ins. Price, $2.00.

Test of a Jet Pump.—By L. R. Balch, C.E., University of Wisconsin. Issued as Bulletin No. 596, engineering series. It presents a description of apparatus, methods of experiments and results and conclusions. Price, 25 cents.

Physical and Chemical Properties of the Petroleums of California.—Technical paper No. 74, United States Bureau of Mines, dealing with the collection, physical and chemical examination of samples and the results therefrom. 34 pages; 6 x 9 ins.

City Plan for Greater Berlin, Ont.—Prepared by Chas. W. Leavitt, New York City. 22 x 30 ins., locating streets, parks, railway lines, etc., through the commercial and residential districts. Also an industrial map of the city of Berlin, 13 x 15 ins.

International Waterways Commission, Canada.—Compiled reports (1905-13), It is a computation of all memoranda reports issued by the Canadian and American sections of the Commission during this period. 1224 pages; 6 x 9 ins.; containing numerous maps and drawings.

A Test of an 8-foot Flash Wheel.—Bulletin No. 598, University of Wisconsin. Prepared by L. R. Balch, C.E., research assistant in hydraulic engineering. It deals with experimental tests, methods, computations, discussion and conclusions. 58 pages; 6 x 9 ins.; illustrated.

Manitoba Public Utilities Commission.—Second Annual Report for the year ending November 30th, 1913. It includes applications, proceedings, orders, etc., together with Mr. R. M. Feustel's report, dated September 15th, 1913, on the Winnipeg street railway service. 152 pages; 6 x 9 ins.

St. Hilaire (Belœil) and Rougemont Mountains, P.Q.—By J. J. O'Neill. Published by Geological Survey, Department of Mines, Canada, as Memoir No. 43. It deals with the physiography, petrology, etc., of these mountains and of the strata in the neighborhood of each. 108 pages; 6 x 9 ins.

The Effect of the Soot in Smoke on Vegetation.—Bulletin No. 7, of the smoke investigation of the Mellon Institute of Industrial Research and School of Specific Industries, University of Pittsburg. An investigation begun in March, 1912, and continued through a year and a half by J. F. Clevenger, M.A. 26 pages; illustrated; 6 x 9 ins.

Infiltration and Leakage in Sewers.—A 61-page booklet published by the Union Clay Products Company, New Brunswick, N.J., containing discussion on the subject by leading authorities as found in proceedings of various societies and other publications. It contains specifications and directions for using joint compound manufactured by the publishers.

American Wood Preservers' Association.—Proceedings of 10th annual meeting, held at New Orleans, La., Jan. 20, 21 and 22, 1914. 408 pages; 6 x 9 ins.; illustrated. The volume contains an account of the convention, papers presented, constitution of the Association, list of members, and statistical information respecting the use of preservatives during 1913.

Investigation of Flow through Large, Submerged Tubes.—Bulletin No. 629, Engineering Series, University of Wisconsin, Part 3, of experiments with submerged draft tubes. By Geo. J. Davis, Jr., C.E., and L. R. Balch, C.E. A description is given of the apparatus used, methods of experimentation and computation and general discussion of results. 57 pages; illustrated.

Geological Notes and Map of Sheep River Gas and Oil Field, Alberta.—Memoir No. 52, Geological Survey, Department of Mines, Canada. Prepared by D. B. Dowling. It contains a description of the geological formations, occurrences of gas and oil in the general region, oil-bearing horizons in various States, and notes on the origin of oil and gas. 26 pages; illustrated.

The Cement Gun and Its Work.—Reprint of a paper read before the Western Society of Engineers, Chicago, by Carl Weber, descriptive of the cement gun, a machine for "shooting" a coating of cement mortar upon construction surfaces, such as concrete, brick, tile, wood and steel work, by the aid of compressed air. Distributed by the Gun-Crete Company, McCormick Building, Chicago.

Investigation of Hydraulic Curve Resistance Experiments with 3-inch Pipe.—Bulletin of the University of Wisconsin, No. 578. Prepared by L. R. Balch, C.E., research assistant in hydraulic engineering under direction of Prof. Geo. J. Davis, Jr., and Prof. Daniel W. Mead. It describes the apparatus used, methods of experiment, computation of results and theoretical consideration of loss of head in bends. 52 pages; 6 x 9 ins. Price, 25 cents.

Safety and Efficiency in Mine Tunnelling.—By D. W. Brunton and J. A. Davis, United States Bureau of Mines Bulletin No. 57. 270 pages; illustrated; 6 x 9 ins. The bulletin deals with various phases of tunnelling operations, describes surface and underground equipment, tunnel construction methods, cost and history of tunnelling. A section is devoted to the cause and prevention of tunnel accidents.

Siphon Spillway Automatic Crest for Dams.—A 16-page booklet issued by the Hydraulic Specialties Company, Limited, Albany, N.Y., describing the two devices invented by Mr. G. F. Stickney for regulating the water level in a canal stream or reservoir and for providing for the disposal of surplus water in time of flood. These devices have been adopted on the New York State Barge Canal, in connection with which Mr. Stickney was a designing engineer.

Abstracts of Current Decisions on Mines and Mining.—By J. W. Thompson, United States Bureau of Mines. It treats of the following subjects: minerals and mineral lands; mining corporations; mining claims; mines and mining operations and statutes relating thereto; mining leases; mining properties; damages for injuries to miners; and operation of quarries. The information contained therein covers investigations made from March to December, 1913. 140 pages; 6 x 9 ins.

Sewer Flushing and Its Cost.—Published by Merritt Hydraulics Company, Philadelphia. 102 pages; 146 illustrations; 6 x 9 ins. This is the second edition of an interesting and useful book on sewer flushing, including a discussion of the cost of flushing at various intervals, ranging from every day to once or twice a week. It includes also a discussion on the design of flush tanks to secure reliability, to prevent water waste, and to secure any frequency of discharge. It has an appendix on sewage pumping and sewage disposal apparatus, and sewer jointing. The book contains the results of experiments and the statements of authorities regarding such important items as the conditions under which deposits will form in a sewer system and flushing will be needed, the amount of flushing water required, and the effectiveness of a flush wave. The reader is referred liberally to available literature in various books and reports and to the files of the leading engineering periodicals.

Engineer's Hand-Book.—A 581-page illustrated handbook of tables, charts and data on the application of centrifugal fans and fan system apparatus, including engines and motors, air-washers, hot blast heaters and systems of air distribution. Published by the Buffalo Forge Co., Buffalo, N.Y., and edited by W. H. Carrier, chief engineer. First edition, 1914. $[illegible]

This book has very complete information for the engineer and the architect on the fundamental principles governing the selection and application of fans for various purposes. It is intended to be used as a guide for them with respect to the above appliances. It indicates that an effort has been made to so standardize the rules and data given that they may be used with any standard make of equipment. The book contains results of tests and research by the engineering staff of the company, much of which has been heretofore published in the proceedings of some of the engineering societies. The information which the book contains is complete and reliable.

CATALOGUES RECEIVED.

Air Compressors.—Four-page illustrated folder, issued by the Canadian Ingersoll-Rand Company, Limited, Montreal, descriptive of several types of convertible steam or belt-driven compressors.

Hydraulically and Electrically-Operated Valves.—Booklet No. 6 of the Rensselaer Valve Company, Troy, N.Y., illustrating various types and sizes, and also clutch attachments for power-operated valves.

Porcelain and Glass Insulators.—A 16-page illustrated bulletin of the Westinghouse Electric and Manufacturing Company descriptive of high-voltage porcelain pin-type and wall insulators and bushings.

Electric Hoists.—A handsomely compiled, 32-page illustrated catalogue describing Sprague electric hoists in capacities from ½ to 6 tons. Canadian General Electric Company, Limited, Toronto, selling agents.

Air-Compressors and Vacuum Pumps.—Eight-page illustrated pamphlet of the Merta Machine Company, Pittsburg, describing their automatic plate valve (Iversen patent) and its advantages; and also their vacuum pumps.

Push-Button Control for Industrial Plants.—An illustrated catalogue descriptive of push-button control as a safety device of importance for manufacturing plants, issued by the Canadian General Electric Company, Toronto.

Aztec Liquid Asphalt for oiling roads. A 28-page illustrated booklet issued by the United States Asphalt Refining Company, containing useful information pertinent to Aztec Asphalt, its source, preparation, qualities, methods of using, and reports of analyses and tests.

Valves and Hydrants.—Catalogue No. 5 and price list of the Kerr Engine Company, Walkerville, Ont., descriptive of brass angle check, globe, gate, radiator and swing check valves; also fire hydrants, flanges, floor stands, indicator posts water cranes, etc. 60 pages; fully illustrated.

Pile Hammers.—A 28-page illustrated booklet of the McKiernan-Terry Drill Company (Canadian agents, Canadian Allis-Chalmers, Limited, Toronto). It depicts the characteristic features of this type of light and heavy-duty hammers, and illustrates a wide variety of uses. Dimensions, prices, specifications, etc., are included.

Good Pavements and Roads in the South.—A handsomely illustrated 24-page booklet descriptive of highways in the Southern States that have been built with Trinidad and Bermudez Lake asphalts, and explanatory of essential features in the construction and maintenance of such roads. Issued by the Barber Asphalt Paving Company, Philadelphia, Pa.

Pneumatic Concrete Mixers.—A handsomely illustrated catalogue issued by the Pneumatic Concrete Placing Company of Canada, Montreal and descriptive of mixers and conveyors and of the operation of mixing and placing concrete by means of compressed air. Some interesting construction views are given of this machinery in use. The above company are Canadian agents for J. H. MacMichael, Chicago.

Centrifugal Pumps.—A 298-page illustrated catalogue of the DeLaval High Efficiency Centrifugal Pumps of single and multi-stage types for various capacities and heads. It is known as catalogue "B," and deals with their characteristics, design, manufacture, testing, selection and adaptation to various uses. It contains special chapters on speed-reducing gears and turbine-driven waterworks pumps. An interesting illustration is that of a 100,000,000-gal. centrifugal pump under test prior to installation in Pittsburg. Another cut illustrates a 16,000,000-gal. steam turbine-driven centrifugal pump, now being installed in Toronto, when under test.

The Industrial Harbor.—A 152-page illustrated booklet descriptive of cranes and transporting appliances of various kinds for the quick handling of goods in modern commercial harbors. Issued by the Demag-Duisburg Deutsche Maschinenfabrik A.G., Germany. Illustrations are given of various harbors throughout the world where there are in operation cranes of the electric travelling, revolving, electrically-driven locomotive, electrical slewing, tower-revolving, grab and portable steam, locomotive jib, electric stationary, semi and full portal, portable and slewing gantry, electrical dischargers, and various other types of cranes, etc. Coal and ore-unloading and transporting plants of various types are included.

PROPOSED AUTO-HIGHWAY IN ENGLAND.

A bill is to be brought before the British Parliament to secure approval for the construction of a highway exclusively confined to automobile traffic, which will be about 50 miles long and 150 feet wide. It is estimated that it will cost $25,000,000; and it is to be constructed by the London, Brighton, and South Coast Motor Road Syndicate Company, Limited. The roadbed proposed is of reinforced concrete with a bituminous surface. Brighton is selected as the southern terminal and Richmond as the entrance of the highway, which will be provided with 3 tracks—the first for fast traffic, the second for heavier vehicles, and the third for autocycles and cyclecars. Wherever the present main roads cross the new roads, bridges will be built; and interference with any other traffic will thus be avoided. According to the plans the entrance to the road at Richmond will be in the form of an ornamental stone arch and a rectangular building for garages, workshops and the sale of accessories. At various points on the road there will be grandstands and workshops. The stands will be for the observation of auto racing on certain specified days, and the workshops for hauling broken-down cars from the road and repairing them. At Brighton terminus there will be ornamental gardens and a bandstand.

The Wabamun Power and Coal Company, of Edmonton, Alta., is preparing to establish a thoroughly modern power plant on its property situated at Wabamun, and has delegated C. J. Grierson and J. Wilson, expert engineers, to visit all the power plants situated in the large cities of the Pacific Coast and middle west states in order to collect first hand information as to the best type of machinery to secure for installation, as well as the cost of the same. R. D. Fetherstonhaugh, mining expert, at present employed with the company, states that three copper and silver claims have been obtained by him for the company in the Omineca country, ore from which is yielding $100 worth of silver per ton. Mr. Fetherstonhaugh will also stake anthracite coal and other claims for the company in the Dunvegan district.

Coast to Coast

Wexford, Ont.—The bridge over the C.P.R. tracks near Wexford, known as the town line bridge, has been completed and opened for traffic.

Medicine Hat, Alta.—It is reported that the Medicine Hat Brick Co. has now in full operation its large plant at Medicine Hat. From 50,000 to 75,000 bricks are being manufactured daily.

Moncton, N.B.—City Engineer Edington, of Moncton, N.B., has submitted for the consideration of the civic board of works plans for street paving for 1914 involving an expenditure of $44,000.

Montreal, Que.—On the recommendation of the board of control, the Montreal city council has voted $294,634.31 to be used mostly in the construction of buildings in connection with various civic departments.

Sussex, N.B.—The new I.C.R. station at Sussex is practically complete and ready for occupation. Also the siding at the military grounds is being improved, and the loading platform is being extended considerably.

Victoria, B.C.—Actual work on the excavation of the 10 miles of trench necessary for the steel pressure pipe line for the Sooke Lake waterworks system between Humpback Reservoir and the city, has been commenced.

Hamilton, Ont.—Estimates have been prepared to be brought before the Wentworth County council amounting in all to approximately $100,000, of which the chief estimate is a road work appropriation amounting to $46,837.60.

Ottawa, Ont.—The Public Works Department or the Ottawa Government has commenced operations on undertakings consisting of harbor and river improvements, and of public buildings, which will aggregate an expenditure of $46,000,000.

Rosser, Man.—A satisfactory adjustment of disputed points has been arranged between the municipal council of Rosser, Man., and governmental authorities in charge of the good roads department; and active road construction in the Rosser district has recommenced.

Halifax, N.S.—It is reported from Halifax that contractors are organizing to commence the construction of a mile of seawall, forty feet high from the bottom and on two great piers, the whole of which construction work will cost $5,000,000.

Canora, Sask.—It has been announced that the present season will see the completion and operation of the new C.N.R. branch from Canora northward as far as Sturgis, a distance of 22 miles. Also two stations are expected to be constructed between these points.

Moose Jaw, Sask.—Engineer Commissioner Mackie has presented to the Moose Jaw city council a report on street grading done during the month of May, showing that 18,000 cubic yards of excavations have been completed at a cost of $46,000, which means an average of about 25 cents per cubic yard.

Halifax, N.S.—A news item from Halifax states that the civic authorities are at present taxed to the utmost to keep the works in progress up to date; that street, sewer, and sidewalk construction is proceeding rapidly, the Clerk of Works having paid out about $12,000 for the past fortnight's labor.

Vancouver, B.C.—The C.N.R. company has placed an order for 45,000 tons of steel rails for the completion of its lines in British Columbia. Five thousand have already been shipped from Sydney, C.B., to Port Mann, B.C.; 5,000 are to be shipped to the Vancouver Island line; 8,000 will be delivered to Kamloops; and 17,000, to the present end of steel, south of Yellowhead Pass.

Calgary, Alta.—Crude black petroleum has been struck at the well of the Monarch Oil Company on section 5, township 32, range 6, west of the fifth meridian, at a depth of 808 feet. The well is about 30 miles west and 6 miles south of the town of Olds, on the Calgary-Edmonton line of the C.P.R., while the Dingman well is about 65 miles southwest of Calgary. At the Dingman well, light oil was struck at a depth of 2,700 feet.

Vancouver, B.C.—An announcement has been made at Ottawa to the effect that the Dominion Government has selected as a site for the new $1,000,000 transfer elevator to be built at Vancouver, a point on the Government dock in Vancouver harbor; and that tenders will be called for the structure within a couple of months. Plans are to be prepared at once. It is expected that the cost will be between $750,000 and $1,000,000.

Winnipeg, Man.—The works and property committee of the Winnipeg city council has estimated that, during the season of 1914-1915 in Winnipeg, public works will cost about $106,900. Of this amount, $15,200 will be required for the maintenance and repair of bridges, $15,000 for street grading, $47,000 for sewer maintenance, $4,000 for sewer ventilation test, etc. The estimated expenditure during 1913 was $101,483; but the actual cost proved to be $116,665.44.

Medicine Hat, Alta.—It is reported from Medicine Hat that building operations totalling an expenditure of $1,500,000 are showing signs of preparation for construction in that city. Some of the structures are a brick and stone block being built by Thomas Mulligan, the enlargement of the present post-office building, the "News" building, a new technical high school, the enlarging of the mill property of the Lake of the Woods Milling Company, and the plant for the Maple Leaf Milling Company.

Victoria, B.C.—It is announced that the first contract to be completed in connection with the Sooke Lake waterworks scheme has just been executed by Messrs. Watson & Cousins, to whom the work of the construction of the telephone line from the lake to Humpback Reservoir, a distance of 27 miles, was let at a figure of $426 per mile. The telephone line is a double metallic circuit, and connects up numerous stations along the line of the pipe grade. Connection with the Humpback Reservoir end of the line will be made into the city.

Galt, Ont.—The Dominion Natural Gas Co. has experienced some difficulty in connection with the construction of the proposed purification plant for Tilbury gas. Delay was caused in the commencement of operations due to the fact that for a certain portion of the work only two firms on the continent were able to tender. It has now been finally decided to build the plant is 3 units, the first of which it is expected to have in operation in a month or six weeks. The other units will be completed within a month and two months, respectively, subsequent to the completion of the first unit.

Windsor, Ont.—It is said by Sir Adam Beck that the work on the Windsor-St. Thomas extension of the Ontario Hydro-Electric Commission's power line, has progressed sufficiently to warrant power being available by the end of July. The engineers are now preparing to make the connection with the local distributing stations at Windsor and Walkerville. For the low-tension line connecting Dresden, Tilbury, Wallaceburg, Strathroy, Lambeth, Embro, Plattsville, Priceville, Fergus, Elora and other places, orders have been placed for the material, some of which has been delivered.

Winnipeg, Man.—The following report on the output from the Winnipeg civic quarries for the month of May, 1914, and the corresponding month of last year, has been published. In 1914, from Stony Mountain, the output of

crushed stone was 183 cars, containing 5,570 yards; [illegible] and [illegible] yards. In 1914, from Bird's Hill, the output of gravel was 189 cars containing 5,370 yards; in 1913, 213 cars and 6,440 yards. In 1914, the sales to the city storekeeper were 4,575½ yards crushed stone, 3,419 yards gravel, 91 yards sand, and 34 yards granite, a total of 8,119½ yards. Last year the sales were: crushed stone, 9,416 yards; gravel, 6,427 yards; sand, 388 yards; granite, 39 yards.

Toronto, Ont.—The contracts which have just been let by the Hydro-Electric Power Commission of Ontario in connection with the development of power at Eugenia Falls, will involve an expenditure of $230,000. The work entailed is the construction of dams, canals and penstocks. Dam No. 1 will be a reinforced concrete structure 2,000 feet long, and varying in height from 40 to 50 feet; while Dam No. 2 will be similar, though not as large. Tenders are now being called for the necessary hydraulic and electrical equipment, which will be used to develop 4,000 horsepower; although the headworks, canals and storage reservoir of the undertaking contemplate an ultimate development of 8,000 horsepower.

Victoria, B.C.—The estimated cost of the work to be undertaken at Songhees Point, Victoria, B.C., and for which tenders are being called, is about $250,000. A retaining wall, approximately 2,000 feet long and 6 feet above high water mark, extending from Songhees Point to the proposed Johnson Street bridge, is to be constructed; and 13 acres of land must be reclaimed. The successful contractors will probably have the option of two alternative schemes in connection with the construction of the retaining wall. One will be by surrounding the site by a cofferdam for the construction of the concrete in the dry, while the other alternative may be by means of cribwork. Considerable dredging will have to be carried out, as it is proposed to have 20 feet of water outside the retaining wall at low tide.

Cobalt, Ont.—A report from Cobalt states that about 120 feet of the Dominion Government 400-foot dam at the foot of Lake Timiskaming, has fallen away; and the cause for this is as yet unfathomed. The portion of the dam affected includes 3 piers on the Quebec side of the dam in the deepest part of the channel, 60 feet of sluice gates and 60 feet of piers. This dam was erected at the foot of the lake at South Timiskaming, and has given considerable trouble previously to the engineers. The water in the lake is falling very fast; and it is estimated that ultimately it will fall ten feet in consequence of this break. This will mean that the new wharf at Ville Marie will not be approachable by boats. The new wharf at Paradis Bay will be in a similar position. The wharves at New Liskeard and Haileybury will be effected only in a minor degree, since there is much better harborage at these points.

Vancouver, B.C.—The mining committee of the Vancouver Board of Trade recently reported to the board in reference to the advisability of encouraging the establishment of an iron and steel industry in Vancouver. The committee stated that there are ample supplies of raw material in the form of magnetite ore on Texada, Nelson, Redonsda and other islands, and on the east and west coast of Vancouver Island. There are supplies of limonite ore at Quatsino, Barclay Sound, Green Lake, Chilliwack and other accessible points. Hematite ores are reported from Bella Coola, Bute Inlet and other points. Vancouver Island coal can be converted into suitable coke by the use of proper retort ovens; while there is plenty of limestone for fluxing to be had at nearby points. The committee also stated that pig iron could be produced at $12.53 a ton, and added that there [illegible] market for [illegible] tons a year at $25 a ton. If local coal cannot be made into proper coke the government is willing to remit the tax on coal imported for coking. There are no known deposits of iron ore of commercial value on the Pacific coast south of British Columbia, but the copper ore shipped out of British Columbia in 1913 totalled 352,300 tons, valued at $3,035,540.

Vancouver, B.C.—Announcement is made to the effect that, between the Okanagan section of the Kettle Valley Railway, rail connections are now in course of construction along the entire route from Midway to Hope, which are to be completed within the next 3 months. The completion of a 15-mile link between Carmi and Penticton will mean that the entire line from Midway to Osprey Lake will be ready for service. Along this section, it is stated that bridge building is proceeding rapidly south of Penticton; and steel has been laid to Osprey Lake from which point a section of line is being built to Penticton. All recent publications in connection with progress being made with all sections of the Kettle Valley road, as well as the section of the V.V. and E., which is to be used conjointly by the two roads, would indicate that rail connection between the boundary and Okanagan points and Merritt, will be completely established this autumn.

Fraser River, B.C.—The work which is provided for by the sum of $60,000 included in the supplementary estimates of the Dominion Government, is the removal of obstructions from the Fraser River, so as to construct a permanent passage for fish to their spawning grounds. Work has been in progress for some time at Hell Gate in the Fraser Canyon, where the river is only about 100 feet wide, and where last December the channel was made considerably narrower by a slide caused by the falling in of the C.N.R. tunnel just above Hell Gate. The contract for the dredging of the channel was given to the Pacific Dredging Company about three months ago; but another six months will be required to complete the work. Night and day shifts have been at work during the past months, and have been moving from 1,000 to 1,500 yards of heavy rock from the bottom of the river to a ledge on the C.P.R. side, 175 feet above water. The rock is being lifted and carried by an overhead cable way which carries a weight of up to 15 tons at each trip and moves 30 feet per second. It is stated that the type of carriage in use is the only one in Canada. It was made in Pittsburg, and carries either buckets full of small rock, or hooks on to 10 or 12-ton rocks. Mr. Stuart Cameron, vice-president of the company, has said that no less than 46 tons of dynamite are being used in the work.

Victoria, B.C.—Mr. J. S. MacLachlan, Government supervising engineer on the breakwater and pier contracts at Victoria, has announced that, during the month of May, 54,114 tons of rock were dumped at the Ogden Point breakwater site. This is a material advance on the amount accomplished in April; while it brings the total amount of rubble dumped since the breakwater contract was started up to 126,504 tons. The increase in May is attributed to the use of a dredge with a capacity of 500 tons. Also, during the month of May, 1,190 tons of granite blocks were laid on the rubble bed under the supervision of divers. Altogether, 1,000 cubic yards of material were excavated and levelled off on the foreshore area during May. This amount is considerably smaller than in previous months. At the site of the piers, during the past month, 7,036 tons of rip-rap were dumped; which material is to form the foundation of the concrete cribwork that is to be constructed on the big floating drydock now moored inside the Inner Harbor. The first shipment of steel is on its way overland to Victoria from the plant of Prior & Co., Nova Scotia; and cement is now under order from the Associated Cement Company, of Bamberton. The Grant Smith & McDonnell quarries at Esquimalt, whence much of the rubble for the contract will be secured, are being opened up; and it is expected that material will be shipped from that point this month.

PERSONAL.

JAS. L. TAYLOR, formerly road superintendent for the County of Wentworth, Ont., has gone to Parry Sound, to accept a similar position there.

A. G. HAULTAIN, for the Canadian Geological Survey, is making a survey of Lake Athabasca, which will serve as a base for all explorations and surveys in the surrounding region.

HANS DEMPWOLFF and TURT SEMMIER, two engineers of the Prussian State Railway System, have been spending several weeks in Canada on an inspection trip of Dominion lines.

THOS. R. LOUDON has been appointed assistant professor of ferro-metallurgy; A. T. LAING, assistant professor of applied mechanics; and A. W. McCONNELL, assistant professor of architecture, at the University of Toronto.

R. L. DOBBIN, B.A.Sc., has been appointed Waterworks Superintendent for the City of Peterborough, Ont. Mr. Dobson has been connected with water supply works in various capacities throughout Canada. A few years ago he was associated with the construction of the Moose Jaw supply line from Caron, Sask.

C. D. KAEDING, formerly assistant general manager of the Goldfield Consolidated, and recently assistant superintendent of mines for the Canadian Copper Co., has been appointed vice-president and general manager of the Dome Mines, Limited, South Porcupine, Ont., and has taken charge of the property, Mr. H. C. Meek, his predecessor, having recently resigned.

OBITUARY.

The Grand Trunk Railway System has suffered a loss through the recent death of Mr. M. M. Reynolds, its vice-president, who for many years had charge of the financial and accounting departments.

A prominent engineer in the person of Mr. Alex. Stewart, assistant chief engineer, Great Northern Railway, died in Seattle, a few days ago. Mr. Stewart was well known in Victoria and Vancouver. The reclamation work at False Creek, the dock on Burrard Inlet, and the other development work carried out by the G.N.R. in Vancouver was done under his supervision.

The death occurred recently in Victoria, B.C., of T. H. Parr, at the age of 66. He was born in England and came to Canada at an early age entering the engineering department of the City of Winnipeg. In 1890 he went to Victoria and engaged in private practice as civil engineer and surveyor. In 1892 he was appointed assistant city engineer of that city under Mr. E. A. Wilmot, and held office for many years. Of late he has not taken an active part in professional affairs.

Owing to the resignation of its secretary, Mr. W. H. Rosevear, the Western Canada Railway Club has, as acting secretary until the annual elections in September, Mr. Louis Kon, Immigration Agent, G.T.P. Ry., Winnipeg.

The 7th annual meeting of the Mine Inspectors' Institute of the United States was held in Pittsburg, a few weeks ago. A large number of delegates from Canada and also from Mexico, were in attendance.

REGINA ENGINEERING SOCIETY.

The personnel of the Regina Engineering Society executive for the present year is as follows:—President, H. S. Carpenter, Board of Highway Commissioners, Saskatchewan Government, Regina; first vice-president, L. A. Thornton, City Commissioner, Regina; second vice-president, R. O. Wynne-Roberts, Consulting Engineer, City Hall, Regina; secretary, J. M. Mackay, Superintendent of Waterworks, Regina; treasurer, R. N. Blackburn, Chief Boiler Inspector, Saskatchewan Government, Regina.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—Seventeenth Annual Meeting to be held in Atlantic City, N.J., June 30th to July 4th, 1914. Edgar Marburg, Secretary-Treasurer, University of Pennsylvania, Philadelphia, Pa.

AMERICAN SOCIETY OF ENGINEERING CONTRACTORS.—Summer convention to be held at Brighton Beach, N.Y., July 3rd and 4th, 1914. Secretary, J. R. Wemlinger, 11 Broadway, New York.

UNION OF CANADIAN MUNICIPALITIES.—Annual Convention to be held in Sherbrooke, Que., August 3rd, 4th and 5th, 1914. Hon. Secretary, W. D. Lighthall, Westmount, Que. Assistant-Secretary, G. S. Wilson, 402 Coristine Building, Montreal.

WESTERN CANADA IRRIGATION ASSOCIATION.—Eighth Annual Meeting to be held at Penticton, B.C., on August 17, 18 and 19. Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

AMERICAN PEAT SOCIETY.—Eight Annual Meeting will be held in Duluth, Minn., on August 20th, 21st and 22nd, 1914. Secretary-Treasurer, Julius Bordollo, 17 Battery Place, New York, N.Y.

CANADIAN FORESTRY ASSOCIATION.—Annual Convention to be held in Halifax, N.S., September 1st to 4th, 1914. Secretary, James Lawler, Journal Building, Ottawa.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Seventh Annual Meeting to be held at Quebec, September 21st and 22nd, 1914. Hon. Secretary, Alcide Chausse, 5 Beaver Hall Square, Montreal.

CONVENTION OF THE AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.—To be held in Boston, Mass., on October 6th, 7th, 8th and 9th, 1914. C. C. Brown, Indianapolis, Ind., Secretary.

AMERICAN HIGHWAYS ASSOCIATION.—Fourth American Road Congress to be held in Atlanta, Ga., November 9th to 13th, 1914. I. S. Pennybacker, Executive Secretary, and Chas. P. Light, Business Manager, Colorado Building, Washington, D.C.

AMERICAN ROAD BUILDERS' ASSOCIATION.—11th Annual Convention; 5th American Good Roads Congress, and 6th Annual Exhibition of Machinery and Materials. International Amphitheatre, Chicago, Ill., December 14th to 18th, 1914. Secretary, E. L. Powers, 150 Nassau St., New York, N.Y.

The City of London, Ont., has 13,978 water services supplied by its Waterworks Department.

A large deposit of silica sand has just been discovered near Redcliff, Alta. Under test it withstands a temperature of 3,000° and possesses properties which indicate its suitability in clay products, iron works and rolling mills. The discovery has aroused considerable interest in Redcliff.

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA

Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from *The Canadian Engineer* for small fee.

21978—June 15—Directing that, within 60 days from date of this Order, C.P.R. install improved type automatic bell at crossing of main approach to Hospital for Insane, London, Ont.; 20 per cent. cost of installing bell be paid out of "Ry. Grade-Crossing Fund," remainder by Railway Company.

21979—June 13—Directing that, within 60 days from date of this Order, Pere Marquette R.R.Co., install improved type of automatic bell at crossing of Head St. (Longwoods Road), Chatham, Ont.; 20 per cent. cost installation be paid out of "Ry. Grade-Crossing Fund," remainder by P.M.R.R. All train movements on siding be flagged over by one of Company's yardmen.

21980—June 8—Approving agreement entered into between Bell Telephone Co. of Canada and King Telephone Co., Limited, dated May 28th, 1914.

21981—June 13—Establishing collection and delivery limits of Dominion Express Co., in town of Morse, Saskatchewan.

21982—June 12—Authorizing C.P.R. to open for traffic its line from Bassano to Empress, mileage 0.0 to 118.3; and from Empress, mileage 111.8, to mileage 110.8, Swift Current Northwest Branch, subject to and upon condition that trains operated over portion from mileage 0 to 75 be limited to speed not exceeding 20 miles an hour; from mileage 75 to 118.3, 18 miles an hour; and from mileage 110.8 to 111.8, 18 miles an hour.

21983—June 12—Approving location G.T.P. Branch Lines Co., station at Lorlie, Sask., Sec. 26-21-10, W. 2 M., Melville-Regina Branch; Station to be in accordance with Co.'s standard Structural Plan No. 1.

21984—June 13—Authorizing G.T.R. to construct siding into premises of Sarnia Bridge Co., Limited, from Sarnia Tunnel Station Yard.

21985—June 11—Authorizing Dominion Atlantic Ry. to construct siding to warehouse of W. H. Chase and Co., Avonport, Co. Kings, N.S.

21986—June 15—Authorizing Lake Erie and Northern Ry. to connect its tracks, temporarily, with siding of M.C.R.R. at Waterford, Ontario.

21987—June 15—Authorizing Esquimalt and Nanaimo Ry. to construct siding for Spragge and Company at mileage 1.35 west of Victoria, B.C.

21988—June 13—Authorizing C.N.O.R. to construct, temporarily, across public road between Lot 19, R. 1, and Lots 23 and 24, North Front A, by spur to Ballast Pit, Tp. Westmeath, subject to conditions contained in resolution.

21989—June 13—Authorizing C.P.R. to use Three (3) bridges—No. 30.8, near Kendry Station, Ont., No. 33.5, near Cavan Station, Ont., and No. 39.4, near Bethany Jct. Station, Ont.

21990—June 15—Amending Order No. 21915, dated June 1st, 1914, by striking out words "Campbellford, Lake Ontario and Western," in recital to Order, and substituting therefor words "Ontario and Quebec."

21991—June 15—Authorizing C.P.R. to re-construct Bridge No. 34.6 on Toronto Subdivision, Ont. Div., at Cavan, Ontario.

21992—June 8—Authorizing G.T.P. Ry. to construct Five (5) Bridges—across creek, mileage 151 east of Prince Rupert; across Shames River, mileage 79, Prince Rupert East; across Hardscrabble Creek, mileage 113.3, Prince Rupert East; across Creek at mileage 115.8 east of Prince Rupert; and across Sand Creek, mileage 115.1, Prince Rupert East, B.C.

[illegible]—June [illegible]—Authorizing C.N.O.R. to open for traffic Orillia Branch from junction with its main line at Udney to Atherley, Ont.; and rescinding Order No. 11308, dated July [illegible]

21994—June 16—Authorizing G.T.P. Ry. to construct spur in S.E. ¼ of Sec. 36-52-2, W. 5 M., mileage 823.64, Dist. North Alberta, Alta., for Alsip Brick and Supply Co., Limited.

21995—June 16—Authorizing G.T.R. to reconstruct bridge No. 301 across Indian River, mile post 105.80, near Thornbury, 14th Dist, of its line, Tp. Collingwood, Ontario.

21996—June 16—Amending Order No. 21114, dated December 30th, 1913,— 1. by inserting word "unopened" before word "highway," where same occurs in recital and operative part of Order. 2. By striking out words and figures, "the said crossings to be constructed in accordance with the Standard Regulations of the Board Affecting Highway Crossings, as amended May 4th, 1910."

21997—June 16—Amending Order No. 21496, dated March 17th, 1914, by inserting word "unopened" before word "highway" where it occurs in Order, and striking out words, "the said crossing to be constructed in accordance with Standard Regulations Affecting Highway Crossings, as amended May 4, 1910."

21998—June 16—Amending Order No. 21495, dated March 17th, 1914, by inserting word "unopened" before word "highway," where it occurs in Order; and striking out words, "the said crossing to be constructed in accordance with Standard Regulations of Board Affecting Highway Crossings, as amended May 4th, 1910."

21999—June 10—Authorizing C.P.R. to construct diversions in Secs. 19 and 29-7-27, W. 2 M., Sask., and construct Weyburn-Stirling Branch Line, at grade, across North and South Road Allowance between Secs. 19 and 30, and Secs. 20 and 29-7-27, W. 2 M., mileage 94.36; and rescinding Order No. 19746, dated July 4th, 1913.

22000—June 15—Directing that C.P.R. provide and construct highway crossing over its railway, Lot 5, Con. 2, Tp. Rayside, Ont.

22001—June 16—Authorizing Winnipeg River Ry. Co., to connect with C.P.R. at Lac Du Bonnet, Manitoba.

22002—June 19—Amending Order No. 21890, May 27th, 1914, by inserting after word and figures, "Sec. 3," in part 1 of recital to Order, word and figure, "Twp. 8;" and striking out figure "8," after word "Twp.," in said part 1, and 2nd paragraph of operative part of Order, and substituting figure "7."

22003—June 19—Amending Order No. 21891, May 27th, 1914, by striking out figures "512" in 2nd line of recital, and substituting therefor figures "312."

22004—June 16—Approving location C.N.R. through Twps. 18-20, R. 7, East of Principal Meridian, Man., mileage 48.56 to 62.72.

22005—June 10—Authorizing C.N.R. to construct across and divert road in S.E. ¼ Sec. 7-43-19, W. 4 M., Alberta.

22006—June 16—Authorizing C.N.R. to re-construct bridge across Red River, at Emerson, Man., subject to condition that Co., at own expense, construct guide pier or protection work should be called upon to do so at any future time by Dept. Public Works of Canada, in interests of navigation.

22007—June 8—Approving agreement entered into between Bell Telephone Co. and Municipal Corporation of Tp. Brooke, dated May 13th, 1914.

22008—June 16—Authorizing C.P.R. to construct stringer opening at Bridge No. 111.45, Hamilton and Goderich Sub. Div., at crossing of Wellington St., town of Goderich, Ontario.

22009—June 16—Authorizing G.T.R. to reconstruct Bridge No. 35, mile post 111.46, 30th Dist., Ottawa, Div., over South Indian River, near South Indian, Tp. Cambridge, Ontario.

22010—June 15—Directing that on and after date of this Order, Sarnia St. Ry. Co., bear and pay cost of maintaining and repairing diamond required to be installed at crossing of G.T.R. by Sarnia St. Ry.; rescinding Order No. 21825, May 14th, 1914, and this Order be without prejudice to rights of G.T.R. or Sarnia St. Ry. with reference to maintenance and repair under Order No. 138.